Volume 8, No. 6 November, 1953

Resolution: Advancing Soil and Water Conservation in the United States

Our Unfinished Business Ahead

... H. WAYNE PRITCHARD

Report of Committee on Wetland Management

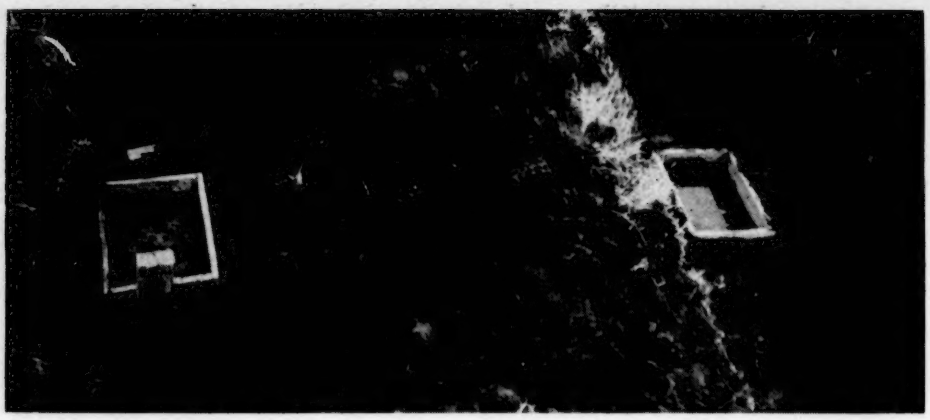
Difficulties in Evaluating the Economics of Soil Conservation

... R. H. BLOSSER

Field Measurements of Soil Splash to Evaluate Ground Cover

... BEN OSBORN

Book Reviews: Vegetation and Watershed Management; The Economic Organization of Agriculture; River on Rampage; Yale Conservation Studies; Game Birds of Colorado and others.



The equivalent of a 2-inch rain was poured into these frames at the same time. The subsoiled strip at the left absorbed 2 inches of water in less than 10 minutes. Water stood for over an hour in the strip not subsoiled.

Home-owned equipment helps store water in the subsoil

A 2-inch "rainfall," poured into the wooden frames above, demonstrated one of the values of subsoiling. In this field, the subsoiled area absorbed 2 inches of water in less than 10 minutes. Where no subsoiling was done, water was still standing an hour later.

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THE COVER:

This excellent photo shows the sizing and grading of spruce and fir for saw-timber, pulp and firewood; also birch for dowal pins on the John Fortin farm near Lancaster, New Hampshire.

Photo by Gordon S. Smith

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An Important Resolution

In the Matter of

Advancing Soil and Water Conservation in the United States

Whereas: The United States Department of Agriculture is in the process of reorganizing departmental activities which may have a profound effect on the future of soil and water conservation in this country; and

Whereas: The objective of the Soil Conservation Society of America is to advance the science and art of good land use; and

Whereas: The Society draws its membership of more than 5,300 from Federal, State, and local government agencies, educational institutions, business, industry, agriculture, and the various professions, including agronomists, engineers, soil scientists, foresters, range managers, hydrologists, educators, economists, biologists and others whose efforts jointly contribute to promoting the conservation of soil and water that the productive capacity of our lands might be constantly improved; and

Whereas: The Society through its publication of the JOURNAL OF SOIL AND WATER CONSERVATION and the programs of its chapters and annual meetings emphasizes the necessity for coordinating the knowledge of specialists and practitioners in many fields of basic and applied sciences to obtain satisfactory results in the application of soil and water conservation and watershed programs; and

Whereas: This coordinated effort of various scientists is essential to effective accomplishment in conservation education, research and application; and

Whereas: Coordinated technical assistance to farmers, ranchers, and other land operators makes possible rapid and successful adoption of conservation measures vitally important to the preservation and improvement of our renewable natural resources;

Now, Therefore, be it resolved: That the Soil Conservation Society of America express the profound conviction that the United States Department of Agriculture, in its present and future plans, should provide adequate, coordinated, and integrated technical assistance to farmers and ranchers, soil conservation districts, watershed associations and other organized groups, so that the needed conservation work on the land can be adopted at a continually accelerating rate;

Be It Further resolved: That the professional organization in the field of soil and water conservation, this Society respectfully requests the privilege to consult with the Department of Agriculture and other related groups relative to any present or future plans in the field of soil and water conservation;

Be It Further resolved: That the Secretary of the Society send a copy of this resolution to the Secretary of Agriculture and representatives of other public and private organizations concerned with soil and water conservation in the United States.

This resolution was approved by the membership at the Eighth Annual Meeting of the Soil Conservation Society of America held in Colorado Springs, Colorado, November 5-7, 1953. It was sent to the Secretary of Agriculture and acknowledged with the following comment: "We appreciate the constructive attitude reflected in this resolution and the offer of cooperation in our efforts to improve services to American Agriculture."—E. T. Benson, Secretary of Agriculture.

Some Remarks Concerning Our Unfinished Business Ahead

H. WAYNE PRITCHARD

TODAY THE CONSERVATIONIST, regardless of his affiliation, is confused and bewildered as to the future of the conservation movement. It is safe to say that few see a charted course ahead. This is not an entirely new situation for there has never been a clear cut, widely accepted policy as to what America was going to do about her land and water resources.

At the present time there is a division of opinion as to how the soil conservation program of this country should be administered to obtain the most efficient results. Part of our task as a professional organization is to supply basic facts as to what is needed to carry out a soil conservation program in the public interest. We, as an organization, are partially to blame for the lack of unity in our thinking. We have considered our past soil conservation program as a good one—we have been contented—and in view of this and the fact we have been so busy working with our specialized interests as agronomists, foresters, technicians, educators, etc., we do not have a proposed national soil conservation program ready to suggest.

Despite our past beliefs and not at our insistence, we find ourselves at a certain crossroads in the conservation movement. As a Society and as professional men searching for facts, we should ask ourselves several soul searching questions. Have we made objective studies of how conservation measures should be applied to land through the guidance of the professional soil conservationist? Have we analyzed the program we have known in the past? Have we measured ourselves as professional conservationists? In answer, we have made a start in the right direction through studies of our technical committees but our organization is still young and our studies are unfortunately not finished.

We have in our membership some of the best agricultural scientists, educators, technicians, and practical conservationists in the world. We have representation from every phase and every level of the conservation movement interested in land use. We have the agronomist, forester, soil scientist, agricultural engineer, the hydrologist, botanist, the educator, the husbandryman, the administrator, press, the industrialist, businessman, and the farmer. What group of individuals is better qualified to offer leadership to the soil conservation movement?

We should have technical committees on many subjects but above all, we should assign ten of our leading members the task of developing a proposed soil conservation program—the ideal, so to speak. Yes, the SOIL CONSERVATION SOCIETY OF AMERICA has a definite role to play. We are living in the day of organizations . . . the day when the strength of a movement is carried forward by organizations. Our members have a great contribution to make and we should lose no time in moving ahead. Our individual members are looked upon as leaders in their respective communities. Through the Society they have the opportunity to affiliate with others in similar positions of leadership.

Where do we start? We should start in the chapters where the member has the opportunity to participate. The chapters should be working on unified programs and this means we need guidance or a national programming committee. The composite results of the various chapters should be compiled on a national level. To carry out this type of program we need strong national and chapter leadership . . . men with leadership ability, with convictions, but above all men with enthusiasm. We need additional chapters and members.

There are those who believe that in the confusion of the moment that organizations such as ours will suffer. I hope that not one member or leader believes this to be true, for when we reach that point the professional conservationist is not fulfilling his own responsibility. We have unfinished business ahead and it can only be accomplished by an enlargement of this organization. By working solidly through the chapters and the national society, we can become the leaders we are looked upon to be. We are on the "state"... we should "play the role."

H. Wayne Pritchard is executive secretary of the Soil Conservation Society of America with headquarters in Des Moines, Iowa. He is also advertising manager of the Journal of Soil & Water Conservation. These remarks by Mr. Pritchard were presented to the membership at the Eighth Annual Meeting of the SCSA held in Colorado Springs, Colorado, November 5-7, 1953.

Field Measurements of Soil Splash to Evaluate Ground Cover

BEN OSBORN

Plant cover on the land surface offers resistance to the kinetic energy of rain storms and protects the soil from detachment and dispersal by raindrop impact. The effectiveness of the cover in preventing soil splash is proportional to the amount present at the time the rain falls.

This is the first of three articles reporting results of field measurements of splash in relation to kinds and amounts of cover. These show that from 4,000 to 6,000 pounds of ground cover per acre, including both standing forage or crops and litter, are required to prevent the initiation of erosion by hard rainstorms, and that soil splash increases rapidly as the amount of cover declines below 2,000 to 3,000 pounds per acre.

These are among the first field measurements which relate the protectivity of the cover to quantitative descriptions of the cover itself. They provide new guides to the use of vegetation in soil conservation. The results should have wide application outside the area where the work was done.

A FIELD SURVEY of soil-protective values of cover under actual farming and ranching conditions in soil conservation districts and flood control watersheds was conducted by the Western Gulf Region of the Soil Conservation Service in 1948 to 1950.

More than 300 plots of ranges, farm pastures, native meadows, and croplands in Texas and Oklahoma were subjected to standardized applications of artificial rainfall. Measurements of soil splash and runoff from these plots provided information on the relative effectiveness of different kinds and amounts of cover in protecting the soil at points of impact of the rain.

These evaluations gave primary attention to the effects of raindrop impact in initiating soil movement on the premise that this is the initial step in soil erosion by rainstorms. The degree to which cover reduces this movement of soil particles by raindrops is therefore a primary measure of its effectiveness in protecting the land.

A consideration of the processes involved in water erosion and of the factors affecting them will aid in understanding the importance of the interception values of cover.

Types of Water Erosion

The forms of water erosion are classified as: (1) *sheet* erosion, (2) *rill* erosion, and (3) *gully* erosion (1). Each succeeding type is associated with the progressive concentration of runoff water into channels as it moves down the slopes of the land.

Sheet erosion is defined as "the more or less even removal of soil in thin layers over an entire segment of sloping land." It is the least conspicuous and the most insidious type of erosion, and affects the greatest proportion of the total land area.

A frequent corollary of sheet erosion is *surface sealing* or crusting of the soil. This is the result of severe structural disturbance of the surface by slaking and by the beating action of the raindrops, accompanied by an assorting action as water flows over the surface and the fine particles are fitted around the larger ones to form a relatively impervious seal (6, 20). The result is to impair infiltration and increase runoff.

Ben Osborn is soil conservationist, Soil Conservation Service, Midland, Texas, and was leader of the field party which made the cover evaluations. The Operations and Research branches of the Service cooperated in the work, under the direction of Louis P. Merrill, regional director, Fort Worth, Texas, and Charles P. Whitfield, project supervisor, Amarillo Conservation Experiment Station, Amarillo, Texas. W. D. Ellison, soil conservationist, now with Bureau of Yards and Docks, Dept. of the Navy, assisted as a consultant in planning the work and evaluating the results.

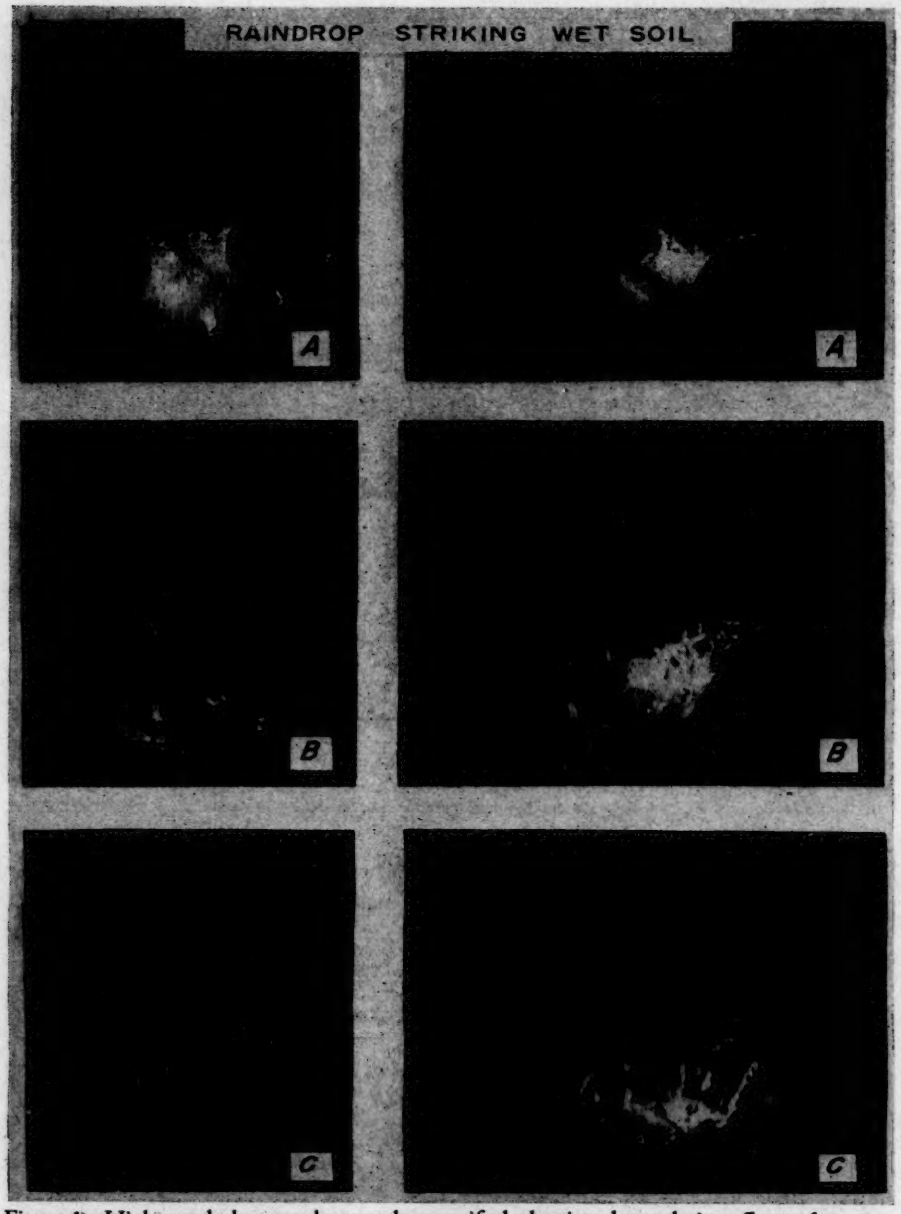

Figure 1—High speed photographs, greatly magnified, showing the explosive effects of a raindrop striking soil. *Left*, soil covered with thin film of water; *Right*, without surface film. (Photos courtesy Naval Research Laboratory.)

It is in connection with sheet erosion and surface sealing that the grasses and other plants of range areas, or cover crops and residues on farmlands, can be of greatest effect in protecting the land. After the water is concentrated into larger and larger channels, there is less opportunity for vegetation to interfere with its destructive action. Consequently, attention in these cover evaluations was concentrated on the relations of cover to sheet erosion.

Factors Affecting Sheet Erosion

Early in the development of the research program of the Soil Conservation Service, Cook (5) pointed out that three major physical factors are involved in the process of erosion by water:

"1. *The soil*, which is the factor acted upon by the process.

"2. *Water*, which in the form of rainfall and runoff is the active agent in the process.

"3. *The plant* (i.e., cover), which acts as nature's intervener in the process."

These act as independent variables, which may be measured in terms of (1) the *erodibility* of the soil, (2) the *erosivity* of the water, and (3) the *protectivity* of the cover.

Cook recognized two distinct actions of water in the erosion process: (1) that of the falling raindrops, and (2) that of the surface flow or unoff. With respect to the former, he said: "During the progress of a storm, some of the raindrops fall upon the bare soil, wetting it, and by their impact loosening the soil particles so that they may be more easily transported by the flowing water. Other portions plunge into the flowing water and, by giving up their kinetic energy in the production of turbulence in the liquid, increase the power of the runoff to scour and transport."

The effect of surface flow is evidenced mainly through "the entrenchment of innumerable minute erosion channels," or scouring and rilling, a type of erosion already well recognized.

Demonstration of the independent capacity of falling raindrops to increase erosion and reduce infiltration was

reported in a summary of studies carried on in the National Bureau of Standards by Cook and Parsons, as reported by Laws (12). By varying drop sizes in artificial rainfall applied to trays of soil, erosion losses, measured in terms of the concentration of soil in the runoff water, were increased as much as 1,200 per cent. Concurrently, rate of infiltration was decreased by 70 per cent. When the distance of fall of the drops was also varied, thereby varying their velocity, the concentration of soil in the runoff was proportional to the total energy per unit area resulting from the drop impacts on the soil surface.

Pursuing this line of investigation, Laws (13) measured terminal velocities for water drops of different sizes and compared them to velocities of natural raindrops. These and other raindrop characteristics as determined by a number of investigators are summarized in a recent publication on raindrops and erosion (2).

At the suggestion of H. H. Bennett, former chief of the Soil Conservation Service, high-speed photographs of drops of water striking soil in various conditions were made at the Massachusetts Institute of Technology by Edgerton, Germeshausen, and Grier, as reported by Laws (12). These showed the explosive effects of the drops striking the surface, hurling soil particles into the air, or creating turbulence in the covering films of water. More recent photographs (Figure 1) made in the Naval Research Laboratory at Washington, D. C., confirm the power of individual drops to set soil particles in motion (11).

It has been demonstrated under field conditions that the principal effect of mulch in reducing soil erosion is through the interception of the falling raindrops rather than retardation of surface flow (4). This was done by covering similar plots by equal amounts of mulch, in one series of which the cover was supported on chicken wire one inch above the soil. When similar amounts of artificial rainfall were applied to the plots, the concentration of soil in the runoff was slightly less from those with the mulch supported above the ground than from the others.

In experimental studies at Coshocton, Ohio, the soil splashed by raindrop impact was collected separately from that carried in the surface flow (7). The splashed material was measured and its properties studied in comparison to the original soil of the test plots. The amount of soil carried in the splash was found to be proportional to the total energy applied to the plots in keeping with the variables of drop size, velocity and intensity (or amount)[1] of rainfall.

In a later series of papers summarizing the foregoing investigations, Ellison (8) defined as "splash erosion" the direct effects of rainfall impact as distinct from the scouring effect of sediment-laden water, and identified as separate phases of the erosion process: (1) detachment by raindrop splash, (2) transportation by splash itself, (3) detachment by forces of surface flow, and (4) transportation by surface flow. With respect to each of these phases, the three major physical factors originally set forth by Cook were recognized; namely, the properties of the *soil*, the *water* (rainfall or runoff), and the *cover*.

Sheet erosion, then, can be considered to be a combination of (1) *splash erosion*, caused by raindrop impact, and (2) *scour erosion*, caused by surface flow. In the first instance, the energy of the rain is applied vertically from above, and in the second it moves horizontally over the surface of the land. The resistance of the cover to these two forces, therefore, needs to be evaluated separately. In the work reported here, consideration was confined to the interception by the cover of the vertically applied force of the falling raindrops.

Stallings (19), in summarizing research on the conservation effects of crop residues, recognized raindrop

Figure 2—A raindrop applicator mounted on a truck is used to test different covers under field conditions on farms and ranches. The tower telescopes for ease in moving.

[1]In these experiments, different amounts of rainfall were applied in a uniform test period of 30 minutes. The results were reported in relation to "intensity" of rainfall in inches per hour. They might as well have been expressed in relation to "amount," since the quantity of soil splashed was propoctional to the total energy in the impact of the drops.

energy as the chief cause of erosion on cultivated land. In some storms and under some combinations of soil and slope conditions, the energy involved in the impact of the drops exceeds that in the runoff. It has been calculated that the energies of a 2-inch rain may reach 6 million foot-pounds per acre (15). This would be true, regardless of the character of the soil or slope of the land on which it falls, whereas the energy in the runoff is dependent upon the volume of water in the surface flow and the velocity imparted to it by the slope of the area. Recent studies of summer rains in Japan showed that the force of the falling raindrops at the point of impact may be as much as 10,000 times that of the surface runoff (14). It is this energy against which surface cover is needed to protect the land from splash and scour erosion.

The fact that other aspects of soil and water losses are not evaluated in the present study does not minimize their importance in a complete conservation program. The abrasive and transporting capacities of running water must be reckoned with and adequate measures used to meet these hazards also.

However, total erosional damages will be reduced to the extent that initiation of soil movement can be prevented by intercepting the falling raindrops before they strike the ground, and surface flow can be avoided by absorption of the water where it falls. The effectiveness of different kinds and amounts of cover in reducing these initial phases of erosion have been measured.

The Cover Evaluations

Equipment. In order to get at the problem on watersheds being treated for soil conservation and flood control, a highly mobile unit for applying rain of known intensity was needed. If actual field conditions were to be evaluated, it was necessary that the tests be made on remote ranches grazed by cattle and sheep and on farms where normal cropping operations were in progress. A mobile raindrop applicator mounted on a 1-ton truck (Figure 2) was designed to meet this need.

This equipment differed from earlier rainfall simulators used in infiltration studies in that the size and velocity of the water drops were controlled so that the total impact of the test application on a plot could be standardized. The water was sprayed from a nozzle in the top of the applicator tower onto a drip screen which formed individual drops of uniform size on yarn drippers. The first equipment of this kind to be used on field plots was tested at the Amarillo Conservation Experiment Station in the spring of 1948. A preliminary report (9) of this work outlined the principles involved and indicated the important results to be obtained from such field tests. From this beginning, an improved model of the raindrop applicator was designed.

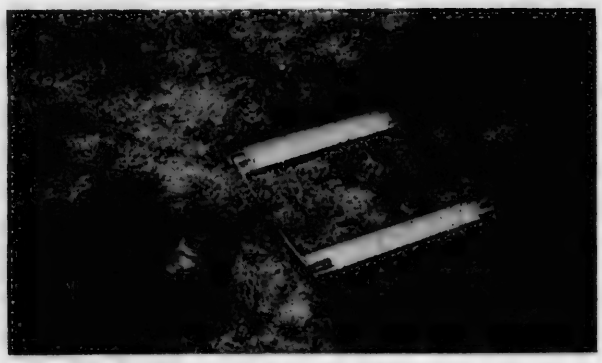

Figure 3—Field plot is enclosed by 12 x 18 inch sampling frame with splash collection troughs and runoff collection jar.

This equipment was used to apply a standardized application of 2 inches of water in 20 minutes to plots representing different kinds and amounts of cover on both range and croplands. The amount of soil splashed and water lost from the plots gave comparative measures of the effectiveness of the cover in shielding the soil and holding water.

Plots were 12 by 18 inches in size. Each plot was enclosed by a metal frame driven into the ground (Figure 3), leaving a rim ½ inch high to keep outside water from running across the plot. Splash plates two feet high protected the plot from water falling outside, and intercepted splashes leaving the plot. Troughs on each side collected a portion of the soil and water splashed out of the plot, and a spout from the lower edge deposited the runoff into a jar during the test. A system of suction tubes collected the runoff and splash into separate jars (Figure 4).

From the amount of oven-dry soil in the splash, the total amount of soil detached and set in motion by the drops, even though not removed from the plot, was calculated. The apparatus was so designed that the actions of running water could not contribute to the removal of the soil caught in the splash. Thus, the results provided an index exclusively to the effects of drop impact in the erosion process.

The total amount of water in the splash and runoff was considered as water lost from the plot, and this subtracted from the amount applied showed the amount held.

Conditions Evaluated. During 1949, evaluations were made of native range cover on 12 important sites in Texas and Oklahoma, including four broad ecological types or associations of range vegetation. Results from 160 plots were complete in all respects and accurate within acceptable limits. On each soil, a series of 8 to 24

plots representing variations in cover from none to the best were evaluated. Each series included examples of each different range condition class under different degrees of grazing use that could be found on the site.

During 1950, attention was devoted primarily to cropland covers, but also to pastures, meadows, and old fields, on farms in central Texas. Results from 158 plots on six different soils met acceptable standards of accuracy. These included 105 plots on croplands, 37 on farm pastures and old fields, and 16 in native meadows.

For evaluating cropland cover, fields representing each of the principal crops on the soil in question were sampled on plots having different amounts of cover. Wherever possible, a bare plot was also tested for comparison.

In order to relate the results to the properties of the cover and soil present, and to discover possible relations between the cover and soil conditions, a variety of detailed information was recorded about both the cover and soil of each site and plot evaluated.

Measuring the Elements of Splash Erosion. Detachment is the principal work performed by the energy of raindrops in the erosion process. As used in this paper, the term refers to the separation from the soil mass and setting in motion of soil particles or aggregates, regardless of direction or distance of movement. Just as with each other aspect of the erosion process, the characteristics of three major elements govern the amount of detachment in any situation; namely, (1) the rain, (2) the soil, and (3) the cover. Techniques have been developed for measuring each of these independently (7, 8, 10, 16).

The capacity of the raindrops to detach soil particles is one aspect of the erosivity of a rainstorm. This *detaching capacity* is expressed as the pounds of soil per acre the drops will detach in the absence of cover, other conditions being standardized. To measure this force in a particular rain, a fine sand of uniform particle size and shape is exposed in a standard cup 3½ inches in diameter (figure 5). This cup excludes the force of surface flow, and is small enough that all the particles moved are thrown free of the container, except for those intercepted by its sides. A formula has been developed for correcting measured results for this interference (3). The amount of sand removed from the cup during a rain is an index of the detaching capacity of the drops. This force varies widely, as might be expected, with the velocity and size of the drops and the amount and intensity of the rainfall.

The ease with which a soil is set in motion by raindrop impact, likewise, is an aspect of its erodibility. The *detachability* of a soil is measured by comparing it to the standard sand, mentioned above. A sample of the soil in question is exposed along with a like sample of standard sand to the same rain or an identical artificial application of water. The amount of soil removed, expressed as a percentage of the amount of sand removed, is the detachability rating of the soil. Natural cores are used for evaluating detachability of soils in field condition. Pulverized samples serve for comparison under standardized physical conditions.

The total *detachment* from a bare soil by raindrop splash during a particular storm is the product of the detaching capacity of the rain and the detachability of the soil. For example, if the rain has sufficient energy to set in motion 100,000 pounds per acre of the standard sand, and the soil has a detachability of 75 per cent, detachment from bare soil under these conditions would be 75,000 pounds per acre. The amount of detachment on a field plot is determined by catching a sample of the soil splashed from the plot and correcting the result by a factor which is calibrated to total detachment as measured from the standard 3½-inch cup (10).

Ground cover, if present, reduces detachment by the extent to which it interferes with the drops striking the soil. The *effectiveness* of cover is expressed as the percentage by which the cover reduces splash from what it would be if the soil were bare (18). That is,

$$\text{Effectiveness} = \frac{\text{Splash from bare soil} - \text{Splash with cover}}{\text{Splash from bare soil}}$$

Where it is possible to measure detachment by the same rain from two plots, one with and one without cover, and it is known that the soil in both is of the same detachability, the effectiveness of the cover can be calculated directly by the above equation. Or, if the detachment is measured from a plot subjected to an artificial application of water of known detaching capacity, and the detachability of the soil is determined, the splash from bare soil can be calculated and substituted in the equation. The latter method was used in determining

Figure 4—Raindrop applicator in operation collects splash and runoff from plot in separate jars.

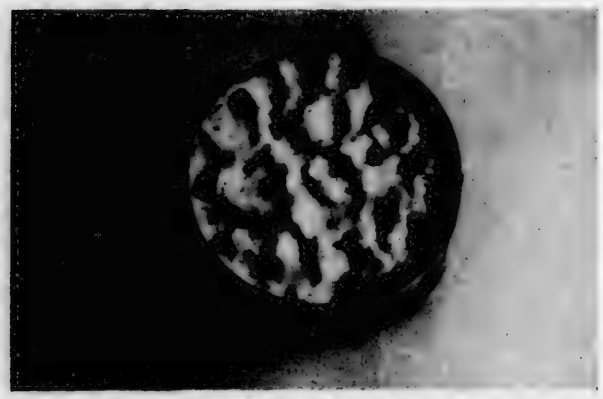

Figure 5—Carefully graded sand in a standard splash cup is used to measure the detaching capacity of raindrops. Note the depth to which the sand has been removed by exposure to a rain, and the imprints of the individual drops.

effectiveness of cover in these evaluations.

Detaching Capacity of the Tests. The capacity of falling drops to detach soil, whether in a natural rain or an artificial application of water, is a function of three factors: velocity of the drops as they strike the soil, diameter of the drops, and the intensity of the rainfall or total number of drops[2] (7). Of these, drop velocity has by far the greatest influence on the amount of soil set in motion. Velocity is, in turn, a function of drop size and distance of fall. In natural rains, the driving force of the wind adds to the velocity of the drops and affects their angle of impact on the soil.

These factors were standardized within reasonable limits in the tests with the raindrop applicator, with rainfall applied for 20 minutes at a rate of six inches per hour. The drops averaged five mm. in diameter. The distance of fall was 14 feet. According to investigations by Laws (13), the velocity of these drops at point of impact would be slightly more than 25 feet per second.

The detaching capacity of this application of water was 110,000 pounds per acre. This is about the equivalent of the hardest rain that occurred at San Angelo, Texas, during the two years this work was in progress (Table 1). Maximum splash of standard sand was 115,200 pounds per acre by a rain of 1.5 inches, which reached a maximum intensity of 7.20 inches per hour for ten minutes. Very few other measurements of detaching capacities of natural rains have been recorded, but it is evident that the application of water used in these evaluations provided a test at least comparable to a heavy thundershower.

Some Significant Findings

These tests showed that native range cover, of every type tested, was sufficient on some examples of every range site to prevent significant soil losses from "points of origin" under field conditions. Cultivated crops, too, were found fully effective on some plots, but generally were inadequate to prevent runoff and erosion under prevailing farming practices.

Likewise, cover and soil conditions can be such as to prevent significant water losses from high intensity rains on soil which have storage and disposal capacities adequate to handle the water as it is absorbed. Certain soils of shallow profile development or with restrictive horizons near the surface did not absorb all the water applied under any cover conditions. On the other hand all soils lost large proportions of the applied water when bare or in a deteriorated condition. Results pertaining to the effect of cover on water intake and runoff are reported elsewhere (17).

The amount of cover on the soil surface at the time of the rain is the primary factor in preventing soil erosion by raindrop impact. Both the bulk and total weight of the cover, and the thoroughness of its distribution over the surface, are important.

Curves expressing the relationship of the effectiveness of cover in reducing soil splash to the amounts of cover of different growth forms per unit area were developed as guides to the use of vegetation in soil conservation. These showed that from 4,000 to 6,000 pounds of ground cover per acre, including both standing forage or crops and litter, are required to provide essentially complete protection, and that soil splash increases rapidly when the amount of cover falls below 2,000 to 3,000 pounds per acre.

In general, the effectiveness of cover in preventing both soil and water losses is greatest on "excellent" condition range, and progressively declines as the degree of current grazing use increases. However, on most sites, soil splash can be controlled even in the poorest range condition by non-use or grazing light enough to leave

Table 1. Detaching Capacities of Rains Principal Rains at San Angelo, Texas, 1949 and 1950

Detaching Capacity *Lb./ac.*	Amount of Rain *In.*	Maximum Intensity for 10 Minutes *In./hr.*	Total Duration *Hrs.*	Date
115,200	1.50	7.20	3.00	April 15, 1949
86,688	1.73	3.30	3.20	September 1, 1949
70,992	3.40	3.00	1.50	September 22, 1950
66,240	3.70	1.80	18.33	October 23-24, 1949
57,888	.77	2.70	.50	May 15, 1950
55,584	1.02	3.90	1.33	March 20, 1950
50,688	1.67	2.10	4.90	April 24, 1949
47,376	1.77	3.90	4.66	May 4, 1949
35,280	.80	2.70	.50	May 25, 1950
30,384	.75	1.00	2.00	May 27, 1949
27,504	1.36	1.50	3.00	August 1, 1950
26,784	.60	.90	1.50	June 5, 1950
26,064	.32	2.00	.50	June 7, 1949

[2]See Footnote 1.

(*Continued on page 266*)

A Study of Some Characteristics of Keene Silt Loam and Muskingum Silt Loam

F. R. DREIBELBIS AND W. H. BENDER

A study of the characteristics of the soil profiles of the Keene and Muskingum series has been made and information given on the mounting of natural soil profiles for exhibit. Such studies aid in the solution of soil- and water-conservation problems.

A contrast of the soil-water relationships has shown that the relative amounts of gravitational, capillary, and hygroscopic water vary with soil type. In the Muskingum, the water drains more readily from saturation to field capacity than in the heavier Keene soil. The latter retains more moisture in the capillary and hygroscopic forms. The available storage capacity for water in a 24-inch soil depth amounts to 8.32 and 8.24 inches for the Keene and Muskingum soils, respectively, at the driest point found under field conditions. As the soil moisture approaches saturation, this storage space is correspondingly reduced. The surface runoff is considerably higher on the Keene soil during the winter and spring months than on the Muskingum. Percolation of water through the profile is greater on the Muskingum soil. Records over an eight-year period show that the average evapo-transpiration is 1.6 inches higher on the Keene silt loam during the growing season—April to September.

A MORE COMPLETE knowledge of the physical and chemical properties of all the recognized soils is needed in order to characterize them more fully and evaluate the relationships among them, particularly in respect to soil classification, soil productivity, and the part they play in the field of soil and water conservation.

In conducting hydrologic studies at the North Appalachian Experimental Watershed, a study of various physical and chemical properties of soil has been made particularly as these properties affect soil water movement. A study of the profiles of the Keene and Muskingum soils has also been made from the standpoint of soil classifiaction and land mapping on the farms in soil conservation districts. A study of contrasts in various soil profiles is part of the training given at the Coshocton Soil Conservation Service Training Center. This paper attempts to summarize the data obtained and coordinate the results so their usefulness may be increased both in the fields of soil classification and in the conservation of soil and water.

Soil Profile Descriptions

Both the Keene and Muskingum soils belong to the Gray Brown Podzolic group of soils which were developed under deciduous forest and in a humid, temperate climate. These soils are common in the hilly unglaciated timber area in eastern Ohio and extending east and south. They are residual soils; the Keene is developed on clay shales, while the Muskingum is developed on sandstone, siltstone, and shale.

The soil profile descriptions and photographs presented above give some idea of the characteristics of these soils and how they appear in nature. In order to give a more vivid description to SCS trainees and others, these profiles were mounted as described below. Because mounting these profiles has resulted in a more forceful presentation of their characteristics, a brief description of the mounting process employed is given here.

Soil profiles of Muskingum silt loam and Keene silt loam were mounted by the junior author using the method developed by Berger and Muckenhirn.[1] The variations adopted were slight and consisted of (1) shortening the profile length by six inches, the final size being 8 inches by 42 inches, (2) both profiles were finished to less than one inch thickness even though they were medium to heavy textures (*silt loam to clay*). Durability under frequent handling and transportation has been found to be greater if the thickness is no greater than about ¾ inch for silt and clay soils. (3) The use of compressed air was found to be a time saver and essential in obtaining a natural apearance of both profiles. However, it must be used with care, or the strong blast will tear out gaping holes. Some profiles have shrunk, cracked, and loosened after six months or a year. An additional application of solution to the loosened area made the profiles appear as good as the original.

Mounting these profiles has aided in contrasting the characteristics of these soils as well as other soils studied in the training courses given to Soil Conservation Service trainees.

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This paper is a contribution from the Soil Conservation Service, Coshocton, Ohio, in cooperation with the Ohio Agricultural Experiment Station, Wooster, Ohio.

[1] K. C. Berger and R. J. Muckenhirn. Soil profiles of natural appearance mounted with vinylite resin. *Soil Sci. Soc. Amer. Proc.* 10: 368-370. 1945.

Muskingum
Silt Loam

Soil Profile Descriptions

Topsoil

The topsoils of both series are similar. They are medium textured (*silt loam*), permeable, friable, moderately acid pH 5.0-6.0, well drained and medium in organic matter content. The Muskingum is brown to yellowish brown in color; the Keene, gray brown.

Subsoil

Muskingum Silt Loam

The subsoil is poorly developed, medium textured containing unweathered rock fragments. It is premeable, friable, moderately acid and well drained. It is yellowish brown in color and free of motling.

Keene Silt Loam

The subsoil is well developed, being a moderately heavy silt loam. It is moderately acid and is slowly permeable. It is yellowish brown in color. The lower subsoil is fairly well developed, moderately heavy in texture (*silty clay loam*), slowly permeable, strongly acid and imperfectly drained; when wet it swells and slows water movement. It is yellowish brown, mottled with gray.

Parent Material

The parent material is only slightly weathered or decomposed mixed sandstone and shale. It is full of rock fragments. It is well drained, strongly acid and medium textured. It is a mass of broken sandstone and shale mixed with finer silty and sandy material which is a product of the weathering of sandstine and shale.

This parent material is made up of acid clay shale. It is heavy in texture (*silty clay loam*), strongly acid and poorly drained. When wet it swells and greatly retards water movement. It is mottled gray, yellowish brown, with gray predominant.

Keene
Silt Loam

The Muskingum silt loam profile was taken from an area which was retired from cultivation over 30 years ago. It was pasture for about ten years and has been idel for the past 20 years. Even though it has been undisturbed for over 30 years, it still bears evidences of the depth it was plowed the last time. Nature has not had time to erase this mark. The remainder of the profile has not been changed by cultivation. The slope of the land in this immediate vicinity is eight per cent. Generally the land slopes on Muskingum soils are steeper than on Keene soils. The cover is poverty grass, briars and a variety of small bushes. The soil characteristics are the same as those of the Muskingum profile from which the data, that appear in this paper, were obtained. This is mentioned because of the wide variation or range of soil characteristics in the Muskingum soils. The range mapped varies from a sandy phase to the heavier silt loam phase which is described herein.

The Keene silt loam profile was taken from an area that has been famed continuously for the past 50 years or more. The principal rotation followed has been a 4-year rotation of corn, wheat, meadow, meadow, or a slight modification of this. The slope of the land in the vicinity of this profile is the same as that where the Muskingum was obtained; namely, eight per cent. The slope on the profile shown is due to unevenness in the land due to plowing and does not represent the general land slope. The soil characteristics are the same as for the Keene profile from which the following data were obtained.

Table 1.—Mechanical analysis of soil profiles adjacent to lysimeters[1]

Soil depth represented, inches	Description	Analysis of total materials, %		Analysis of particles < 2 mm., %		
		> 2 mm.	< 2 mm.	Total sand 2-0.05 mm.	Total silt 0.05-0.002 mm.	Total clay < 0.002 mm.
	Lysimeter Y-102, Muskingum Silt Loam (Shale)					
0-7	Brown to yellowish brown silt loam	8.2	91.8	28.9	63.4	7.7
7-14	Yellowish brown silt loam slightly heavier than surface soil	3.2	96.8	27.1	54.7	18.2
14-24	Yellowish brown silt loam to fine sandy loam	6.2	93.8	54.9	27.3	17.7
24-39	Decomposed sandy shale	1.1	98.9	61.0	24.8	14.2
39-46	Mottled gray and rust brown clay shale	24.8	75.2	48.8	33.9	17.3
46-60	Decomposed silty shale	53.3	46.7	57.9	28.7	13.4
60-74	Shale in first stages of decomposition	No data	---	---	---	---
74-96	Bedrock (shale)	No data	—	---	—	—
	Lysimeter Y103, Keene Silt Loam					
0-8	Gray brown silt loam	1.1	98.9	10.6	78.4	11.0
8-15	Yellowish brown silt loam, unmottled	5.2	94.8	8.1	77.8	14.1
15-27	Yellowish brown silt loam to silty clay loam slightly mottled with gray	2.4	97.6	9.1	63.4	27.5
27-41	Mottled gray, yellowish brown, and rust brown silty clay loam; gray predominant	0.5	99.5	9.3	53.1	37.6
41-60	Gray heavy silty clay loam containing shale fragments	2.2	97.8	8.2	54.2	37.6
60-83	Mostly decomposed clay shale	74.3	25.7	8.8	62.4	28.8
83-96	Partially decomposed clay shale	76.8	23.2	14.2	62.1	23.7

[1]Analysis by F. R. Dreibelbis and F. A. Post.

Soil Properties

Mechanical Analysis and Physical Properties. A study of such soil properties as particle size distribution, volume weight, total pore space, and pore size distribution and their relationship to water movement will help to understand the basic principles of soil and water conservation and other agricultural problems.

Particle size distribution information is obtained from a mechanical analysis which gives the relative amounts of sand, silt and clay present. Values for the Keene and Muskingum profiles which were obtained adjacent to the lysimeter sites appear in Table 1. The Muskingum profile has a higher content of sand and coarse fragments and a lower content of silt and clay particles. The characteristics of the respective subsoils and substrata are the main differences between these soil types. The Muskingum being lighter textured drains readily, while the high clay and colloidal content of the Keene profile produce an entirely different drainage behavior. The silty clay loam layer in the Keene profile has a clay content of 37.6 per cent. Further information on some physical properties of these soils appears in Table 2.

Volume weight data are useful in the determination of total pore space, and in the conversion of soil moisture to the volume basis. The volume weight also gives an evaluation of the compactness of the soil.

Total pore space decreases with soil depth. The total pore space shows the relative amount of water the soil can hold because the pores are always filled with air and water. When completely saturated, the pores are filled with water.

The moisture equivalent is useful as an index of the field capacity of the soil. The values given are based on material passed through a two mm. sieve. Actually, the Muskingum soil has a lower value because of the higher proportion of coarse parent material fragments greater than two mm.

The data in Table 3 show the various forms of moisture found in the soil and the relative force with which this moisture is held. These values of soil moisture are often expressed on an energy basis, thus giving a good picture of the manner in which moisture is held by the soil. At saturation the water is held loosely in the noncapillary pores and drains readily. This is commonly referred to as detention storage. The capillary moisture is held by the soil particle against the force of gravity and does not contribute to drainage. This is referred to as retention storage. Water in retention storage is available for use by plants and for evaporation. It is unavailable for stream flow. The hygroscopic moisture is held so firmly by the soil that roots cannot extract it rapidly enough and plants wilt. It is the moisture an oven-dry soil will acquire upon standing due to the humidity of the atmosphere. The relative amounts of the different forms of soil water vary with soil type. The

Table 2.—Data on some physical properties

Location	Soil type	Soil depth (inches)	Volume weight	Total pore space (per cent)	Moisture equivalent
Watershed 123	Keene silt loam	0-7	1.22	51	25.8
—do—	—do—	7-14	1.42	49	26.4
—do—	—do—	14-20	1.55	44	24.8
—do—	—do—	20-40	1.80	48	26.2
Watershed 109	Muskingum silt loam	0-7	1.25	51	24.3
—do—	—do—	7-14	1.47	42	24.5
—do—	—do—	14-24	1.65	35	24.5
—do—	—do—	24-40	1.64	37	24.1

Table 3.—Soil moisture characteristics of the Keene silt loam and the Muskingum silt loam, 0-14-inch depth

Soil depth (inches)	Description of moisture	Storage under field conditions—inches water per inch of soil K[2]	Storage under field conditions—inches water per inch of soil M[3]	Relative wetness	pF[1]
0-7				Oven dry	7.0
	Hygroscopic—unavailable to plants	0.05	0.05	Very dry	4.5
	Capillary—available to plants	.26 (.31)[4]	0.24 (.29)[4]		
	Field capacity	(.31)	(.29)	Moist	2.7
	Gravitational	.08 (.39)	.08 (.37)		
	Gravitational—drains readily	.12 (.51)	.14 (.51)	Wet	1.6
	Saturated	(.51)	(.51)	Very wet	0
7-14				Oven dry	7.0
	Hygroscopic—unavailable to plants	.09	.07	Very dry	4.5
	Capillary—available to plants	.27 (.36)	.24 (.31)		
	Field capacity	(.36)	(.31)	Moist	2.7
	Gravitational	.06 (.42)	.06 (.37)	Wet	1.6
	Gravitational—drains readily	.08 (.50)	.11 (.48)		
	Saturated	(.50)	(.48)	Very wet	0

[1]pF is the logarithm of the capillary potential which expresses the energy with which water is held by the soil.
[2]Keene silt loam.
[3]Muskingum silt loam.
[4]Figures in parentheses are cumulative totals.

Muskingum loses water more readily at saturation than the heavier Keene soil. The latter retains more moisture both in the capillary and hygroscopic form.

The data in Table 4 show the amount of soil water held at saturation and at the lowest soil moisture content found under field conditions. The difference represents the maximum available storage capacity. When the soil is nearly saturated, this storage space is already used up or nearly so. As the soil dries out, more storage space becomes available. Under the driest conditions found in the field, the 24-inch soil depth has an available storage of 8.32 and 8.24 inches on the Keene and Muskingum soils, respectively. The retention storage on the Keene soil amounts to 5.49 inches, while on the Muskingum, it is 4.91. The detention storage in the 24-inch depth amounts to 2.83 and 3.33 inches on the Keene and Muskingum soils, respectively.

This concept of potential water storage should be emphasized because it illustrates the large amount of water the soil can absorb if the proper conditions permit its infiltration. This storage space is likely to be the greatest during the growing season when high evapo-transpiration rates remove water rapidly from the soil. During winter and early spring when the soil moisture is ordinarily very high, and evapo-transpiration rates are low, little available storage space is left.

Soil type effects on surface runoff. Soil type has an important influence on surface runoff. These effects as illustrated in Figure 2 show the average monthly runoff for the period 1939-1950 for two watersheds—one on Keene silt loam and one on Muskingum silt loam. Land use practices were the same on these watersheds since 1937. During the winter and early spring months runoff is much higher on the Keene watershed. At this time of year the soil moisture is often above field capacity on the Keene silt loam but on the Muskingum it drains away readily. When storms of low intensity occur the Keene profile soon becomes saturated and runoff begins. On the Muskingum areas most of the rainfall infiltrates into the soil during this season because the good drainage provides available storage space for most of the rainfall. In the Keene subsoil the large amount of colloids swell sufficiently to make the subsoil almost impermeable. Consequently, a large storm will soon produce runoff because the available storage space is soon exhausted.

During the summer months runoff is higher on the Muskingum area. At this time evapo-transpiration rates are so high that the available storage is almost equal on both soils. When high intensity rains occur, which are common in the summer, surface sealing often takes place and runoff is generally greater on the Muskingum area due probably to the greater slope.

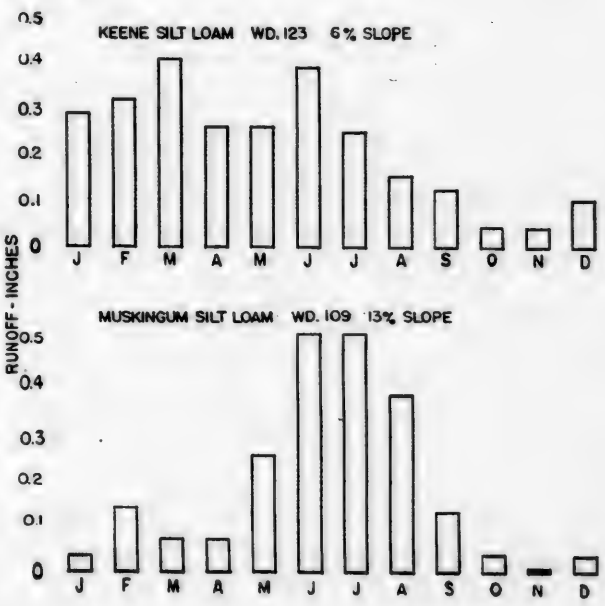
Table 4.—Maximum and minimum soil moisture values and the available storage capacity (Expressed in inches water)

Soil type	Soil depth	Calculated maximum possible water storage	Minimum field soil moisture found	Difference (maximum available storage capacity)	Detention storage	Retention storage
Keene	0-7	3.57	0.35	3.22	1.40	1.82
silt	7-14	3.50	.70	2.80	.98	1.82
loam	14-24	4.40	2.10	2.30	.45	1.85
Total	0-24	11.47	3.15	8.32	2.83	5.49
Muskingum	0-7	3.57	.35	3.22	1.54	1.68
silt	7-14	3.36	.64	2.72	1.19	1.53
loam	14-24	3.50	1.20	2.30	.60	1.70
Total	0-24	10.43	2.19	8.24	3.33	4.91

Soil type effects on percolation. Soil type also has an important influence on percolation. Over a period of years amounts and rates of percolation are generally higher on the Muskingum soils. This is due largely to the abundance of coarse parent material fragments throughout the profile and to the relatively small amount of clay and fine colloidal material present. The structure of the subsoil also favors rapid percolation. In the Keene subsoil the large amount of clay and colloidal material produce appreciable swelling when wet, making the soil almost impermeable. During prolonged dry periods, as frequently occur in late sumer and early fall, considerable shrinking of the silty clay loam layers in the Keene profile occurs. This frequently results in erratic percolation rates when storms follow such dry periods. Under such conditions percolation rates are more rapid on the Keene soils due to percolation along the cracks in the subsoil produced by soil shrinking. These erratic rates continue until the soil swells sufficiently to close these cracks, after which rates become extremely slow. In Figure 3 are shown average monthly percolation amounts from monolith lysimeters for the period 1940-1951. These monthly values are higher on the Muskingum soils for all months except November, December and January when they are slightly lower. This is the period when erratic percolation rates are most likely to occur on the Keene soils because it follows a late spring and summer period when depletion rates by evapotranspiration are high, thereby reducing the soil moisture content to the lowest point of the year. The cracks produced in the subsoil of the Keene soils by shrinking gradually close, and by the end of January or February, rates are much lower. The meteorological conditions vary from year to year and some years these cracks do not close even until late winter or spring. In other years, they may close much sooner. The data in Figure 3 also show that most of the percolation occurs in the first four months of the year. For the 12-year period, when land use practices were the same on both areas, 78 per cent and 79 per cent of the annual percolation occurred in these four months on the Keene and Muskingum soils, respectively. The biggest contrast in monthly amounts of percolation from these soils occurs in the months of March, April and May when they are much higher on the Muskingum soil. The total annual percolation for the 12-year period averaged 6.4 inches on the Keene and 8.3 inches on the Muskingum soils. The maximum annual percolation occurred in 1950, amounting to 16.0 and 12.6 on the Muskingum and Keene soils respectively; the minimum, in 1941, amounting to 2.6 and 2.1 inches, respectively.

Soil type effects on evapo-transpiration. There appears to be some difference in evapo-transpiration rates due to soil type effects. Since the Muskingum soils are better drained and retain less soil moisture at the same tension than do the Keene soils, it is apparent that more soil moisture is present in the latter soils. Records are available over an 8-year period which show that the Keene soils have lost an annual average amount of 1.6 inches more water by evapo-transpiration than the Mus-

Figure 1.



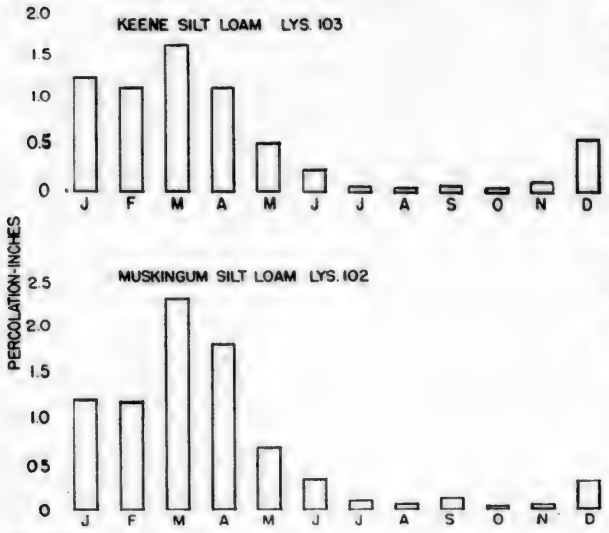


Figure 2.

kingum during the growing season—April to September.[1] These data were obtained from weighing monolith lysimeters for the period 1944-1951. Every year but one (1947), the depletion due to evapo-transpiration for the growing season was greater on the Keene silt loam.

Data on the chemical analysis of the Keene and Muskingum profiles were previously presented by Harrold and Dreibelbis.[1] The chemical constituents of soil, while of great interest, do not exert much influence on soil-water movement.

[1]For more detailed studies, see L. L. HARROLD AND F. R. DREIBELBIS—Agricultural Hydrology as Evaluated by Monolith Lysimeters: *U.S.D.A. Tech. Bull. No. 1050.* December 1951.

Field Measurements of Soil Splash to Evaluate Ground Cover

(*Continued from page 260*)

sufficient cover on the surface to intercept the rainfall. When the soil surface is stabilized, conditions are favorable for improved water intake and development of the cover toward superior and more productive range condition classes.

Cover and soil conditions of native meadows usually are comparable to those of "excellent" condition ranges, except where annual burning has prevented accumulation of litter on the ground and exposed the soil between the grass clumps.

Intensively grazed farm pastures in the humid areas generally had sufficient cover to prevent soil splash, but the soil surface was compacted and water losses were excessive.

The soil-protective values of crop covers may be influenced as much by the way the crops are utilized and their residues managed as by the kinds of crops grown. Some "soil-depleting" crops produce a greater bulk of cover at some seasons than many crops grown especially for erosion control. The spacing of the crops, the manner of harvesting, degree of grazing in fields, and disposition of the residues largely govern the amount and distribution of the cover on the soil surface at any season.

Further detailed results of these evaluations will be presented in subsequent issues of the JOURNAL OF SOIL AND WATER CONSERVATION.

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Difficulties in Evaluating the Economics of Soil Conservation

R. H. BLOSSER

Much as the economist would like to, he cannot always assign definite dollars and cents values to soil conservation practices. Many practices are so interrelated and their effects so confounded by the interplay of weather, fertilizers, timeliness of operations and general management that it is difficult to measure their value except in general over-all terms. The agricultural economist hopes that this article will stimulate our readers to suggest techniques that will help in evaluating soil conservation. The best ideas often come from those who do not know that "it can't be done."

CONSIDERABLE EMPHASIS is now being placed on farming methods and practices as a means of saving soil resources. Since soil conservation recommendations often involve major changes in present farm organization, many farmers ask the question, "Does conservation farming pay?" Costs and returns from soil conservation increase in importance as more farmers become interested in adopting needed practices. A few farmers may apply more conservation measures because they believe they should conserve the soil for future generations. However, most are interested in land management from the economic standpoint. They prefer to adopt conservation practices only to the point where net income can be maximized for a certain period of time. In many cases these farmers want to know how the proposed changes will affect farm organization and income before they adopt them.

The purpose of this discussion is to consider some of the difficulties involved in calculating the economic benefits of soil conservation. Costs and returns from conservation measures vary according to the amount applied. Controlled experiments and data from actual farms do not always give the desired economic information. Direct benefits from soil conservation practices are often considerably different from the indirect benefits. Economic returns from the short time point of view are usually different from the benefits over a longer period of time. Conclusions regarding economic benefits are also influenced by the methods of measurement.

Different Degrees of Soil Conservation Possible

Potential returns from additional soil conservation practices are difficult to calculate in simple terms because conservation farming is a matter of degree. Different levels are possible on many farms because of the number of practices recommended. For example, some farmers follow a good rotation, but fail to adopt the mechanical practices recommended for their farms. Others apply adequate amounts of lime and fertilizer on the cropland, but continue to follow soil depleting rotations. Different levels of consevation farming exist because of differences in the intensity of application. For example, some farmers apply larger amounts of lime and fertilizer than others. Considerable variation often exists in the amount of meadow crops raised in the rotation.

Since conservation farming is a matter of degree, economic considerations depend upon the objectives to be accomplished. One objective might be to manage land resources so that erosion losses would be zero. Another objective might be to increase the productivity of the soil and maintain it at some previous level. In some cases the goal might be to maintain soil productivity at the present level. For some soils the goal might be depletion to lower levels before stabilizing productivity. Additional conservation practices might also be applied as long as marginal costs did not exceed marginal revenue. Some of these goals would require using larger areas for permanent pasture and woods than others. They might also require a high percentage of meadow crops on certain soil types.

The relationship between conservation farming and net farm income is illustrated in Figure 1. This chart shows that the amount of soil conservation practices applied to any farm may vary from small to extremely large amounts (represented by *O* and *Y*). As additional amounts of soil conservation are added, net income increases up to a certain point (marked *M*) and then declines. This situation occurs because all conservation practices may be applied to the point of diminishing returns. For example, fertilizer and lime can be applied in varying amounts until marginal costs are greater than marginal revenue. Meadow crops may be increased to the point where farm income actually declines, especially on farms where the additional forage is plowed under or fed to inefficient livestock. Contour strips could be made so narrow that the additional benefits did not pay for the additional costs and inconveniences. Tile lines can be spaced so closely that additional amounts do not pay for the extra costs.

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In Figure 1, comparisons between any two points with less than *X* units of conservation show that additional units increase profits. Applications between *X* and *Y* would produce less income because of diminishing returns from each additional unit. Comparisons between *A* and *B* would show certain differences in income from more soil conservation. Comparisons between *A* and *M* would show a greater difference in favor of larger amounts of conservation. Comparisons between *M* and *C* would actually show a slightly smaller income from the extremely high rates of application. Under actual farm conditions the amount of soil conservation that will give maximum profits depends upon many factors. Some of the major ones will be considered in the remainder of this discussion.

Data from Controlled Experiments

Controlled experiments are usually conducted at an experiment station where all factors are presumably held constant, except the ones being studied. Station experiments are usually limited to the study of individual practices because of the complexity of measuring different degrees and intensity of soil conservation. Economic benefits from a complete soil conservation program are often difficult to evaluate from individual practice data. For example, returns from several practices seldom equal the sum of the practices taken individually. In some cases they may be more; in other cases they may be less. Most farmers are interested in the economics of applying several practices in combination. Few farmers adopt only one soil conservation practice.

Costs and returns of individual practices are often difficult to determine even, under controlled experiments. For example, it is difficult to calculate accurately how much sod waterways increase crop yields and income. However, they contribute to the ease of operating machinery on slopes subject to gulley erosion. Returns from contour strip cropping are influenced by such factors as rotations, soil types and past land management.

Controlled experiments are usually limited to a few soil types. Therefore, the data are often inadequate for many of the major soil associations. Some soils may be depleted in productivity and restored to previous levels without any permanent damage. In this case, costs of soil depletion are actually the costs of restoring the productivity to some previous level. In addition to these temporary losses, other costs must be considered when permanent damage results from erosion. These costs will vary according to soil type and amount of erosion. The economics of soil conservation is affected also by the rate of soil erosion and fertility depletion. Some soils may be depleted to unprofitable levels in a shorter period of time than others.

Individual practice data are often inadequate in showing the effects upon general farm organization. Fences may need changing to establish contour strip cropping, or longer rotations. Field arrangement may be improved on some farms by fencing on the countour. On other farms, additional lanes and watering facilities may be needed for livestock because new fields do not connect with the barnlot. Contour cultivation may produce longer rows on some farms, but on others point and crooked rows may interfere with the use of modern farm machinery. Data on rotations with more meadow crops do not show the additional costs for buildings and livestock to utilize more forage. Data on terracing seldom show the problems involved in maintaining terrace outlets. To protect these outlets on hog farms, the farmer usually has to fence the outlet or pasture the hogs in another field.

Data from Actual Farms

Soil conservation data from actual farms usually cover a wider range of soil types and farming conditions than controlled experiments. Data from farms show the steps taken by farmers in adopting different conservation programs. Direct contacts with farmers provide information on the difficulties of establishing additional conservation measures. Farm records also show how certain farmers have adjusted their livestock programs to utilize more forage crops.

Under actual farm conditions, data from different farms are often difficult to compare because of wide variations in size of farm, type of soil, kind of livestock, methods of management and applications of lime and fertilizer. Some farmers may not apply large amounts of fertilizer until grain yields decline to low levels. Therefore, high applications of fertilizer are not always correlated with high yields because of past land management. Data on previous farming practices are difficult to obtain because of changes in farm operators and inadequate records.

Records kept on the same farm over a long period of time often have the advantage of the same operator, land resources and size of farm. However, many factors are not comparable for long periods of time. For example, the managerial ability of a farmer may improve from experience, but as he gets older he may work less for various reasons. The type and amount of livestock may vary over a period of time and still have no relationship to soil conservation. Over long periods of time increases in farm income may result from technological changes in farming as well as the addition of soil conservation practices. On many farms income could have increased during the last 15 years by merely changing from horse to tractor power, or raising hybrid corn. Actual income figures seldom show how much resulted from additional

conservation measures, and how much was due to other changes in farm organization.

Direct vs. Indirect Benefits

Direct benefits from soil conservation practices are often considerably different from the indirect benefits. Returns from rotations with more meadow crops depend upon whether the additional forage is plowed under, sold or fed. For most soils some meadow crops are needed in the rotation for maximum grain production. Under This relationship exists as long as reductions in acreage certain conditions additional meadow crops not only increase forage production, but also total grain production. of grain are offset by sufficient increases in yields per acre. As long as total grain production increases when more meadows are raised, additional forage presents no problem. In this case hay can be turned under and income will still be higher than it would be if less acres of hay were raised. This is due to the fact that a reduction in the acreage of meadows would decrease the production of both grain and forage.

The amount that grain yields must increase to maintain total grain production when more hay is added to the rotation will depend upon (1) the present amount of meadow crops, (2) grain yields and (3) proposed rotations. For example, grain yields per acre must increase one-third if total grain production is to remain the same under a rotation of corn, small grain and two years of meadow compared with corn, small grain and one year of meadow. If corn yields average 45 bushels per acre for the three-year rotation, 60 bushels must be obtained under the four-year rotation to offset the reduction in corn acreage. In this case an increase of 15 bushels per acre is needed to maintain total corn production. If corn yields average 75 bushels per acre for the three-year rotation, 100 bushels per acre will be needed under the four-year rotation to maintain total corn production. In this case an increase of 25 bushels per acre is needed. The same proportionate increase also would be needed for the small grain crops.

As more acreage of meadows is added to the rotation, a point is reached where total grain production declines. This occurs whenever yields per acre fail to increase fast enough to offset reductions in grain acreage. When total grain production declines as a result of adding more hay crops, net receipts often decline unless some income is obtained from forage crops. Economic returns from meadow crops will depend upon whether they are sold directly or fed to livestock. When fed, profits will depend upon the type and efficiency of the livestock kept, and the price of livestock and its products.

Returns from rotations with more meadow crops will be low if large amounts of hay and pasture are fed to

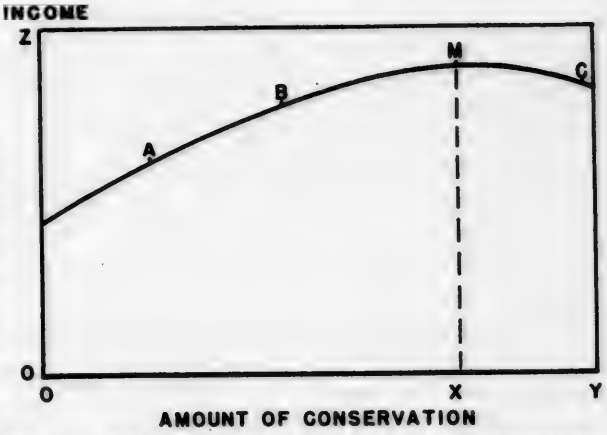

FIG. 1.- RELATIONSHIP BETWEEN SOIL CONSERVATION AND FARM INCOME

inefficient livestock. On the other hand, additional meadow crops may increase net farm income on some farms when fed to high producing animals. Returns from feeding more forage to dairy cows will be less in areas where the price of milk is low, and more in areas where the price is higher. The higher grain yields are, the higher the returns must be from hay and pasture to offset losses in income from less acres of grain. For example, forage fed to low producing dairy cows might return as much per hour of labor as 45 bushels of corn per acre. But considerably higher producing dairy cows would be needed to give the same return per hour of labor from forage as 75 bushels of corn per acre.

Short Time vs. Long Time Benefits

The economics of soil conservation depends upon the period of time considered. In many cases returns from the short time point of view are different from the benefits over a longer period of time. Individual farmers are usually interested in soil conservation for a shorter period of time than society. Therefore, the most economic application of practices for the farmer may not be the most desirable for society. Economic returns often vary during the transition period and the time the program is in full operation. Net income will increase on many farms after sufficient time has elapsed to recover additional costs for soil conservation and changes in farm organization. However, during the transition period, net income may actually decline on some farms. For example, costs of liming cropland are not recovered on many farms until a meadow crop can be produced and marketed through livestock. Several years are usually required before the benefits of permanent pasture improvement are fully realized.

Higher grain yields from conservation rotations cannot be expected until better meadows are raised and

larger residues plowed under. In the meantime total grain production may decline because of reduction in grain acreage. This situation may reduce farm income until grain yields increase per acre, and necessary adjustments are made in farm organization. Several years may be required before economic gains from terracing equal cost of construction. Fencing woods against livestock and planting trees will have little effect on increasing immediate farm income. Concrete structures may greatly increase cash outlays the year they are made. Expenditures for housing additional livestock cannot be recovered as quickly when new buildings are constructed as they can when present ones need only minor repairs.

The economics of conservation farming is difficult to determine over a period of time because of changes in prices. Different price relationships produce different costs and returns for soil conservation practices. For example, if the cost of lime and fertilizer increases relative to product prices and other farm costs, profits will be maximized by using less of these factors of production. Likewise, if costs of these two factors decline relative to other expenses, profits will be maximized by using more of these factors and less of others. Price relationships often change over a period of time. For example in 1932 only 338 pounds of milk were required to give the same gross receipts as 100 pounds of pork. But, in 1945-49 this relationships changed so that 486 pounds of milk in Ohio were required to equal the price of 100 pounds of pork. When the price of hogs increases relative to milk, profits might be increased on some farms by raising more grain and less hay provided adequate soil conservation practices are followed. When the price of milk increases relative to hogs, profits might be maximized by raising more meadow and less grain crops. Returns from soil conservation practices are difficult to calculate for the agricultural industry as a whole. Over a period of time if too many farmers kept more dairy cows to utilize additional forage, the price of milk would probably decline to unprofitable levels for many producers.

Returns Depend Upon Units of Measurement

Economic benefits of soil conservation depend upon whether measurements are made in terms of (1) income per farm, or (2) income per hour of man labor. More meadow crops may increase net income on many farms, the amount depending upon how the additional forage is utilized. On some farms this increase in income may be accomplished with more efficient use of labor. In this case the farmer would not only increase his total income, but he would also increase the return per hour for his labor.

In some cases more meadow crops in the rotation may increase net income per farm, but more labor would be required to care for the additional livestock. On these farms less grain and more hay would increase total income, but returns per hour of man labor would be less. In other words, total income would increase because the farmer worked harder but received less per hour for his labor. This situation occurs whenever forage crops produce less income per hour of labor than grain. Inefficient livestock and high grain yields are often responsible for the smaller hourly returns from meadow crops. Maximum returns per hour of labor may not be as important as maximum returns per farm in cases where there is plenty of labor but a small acreage of land.

Summary

1. The economics of soil conservation is difficult to evaluate because many factors influence returns.
2. Economic benefits can be calculated for different amounts and intensities.
3. Economic returns from a complete program are difficult to calculate from controlled experiments where practices are studied individually.
4. Costs and returns of some practices can only be estimated because of joint relationships.
5. Under actual farm conditions data on conservation farming are difficult to compare because of variations in such factors as size of farm, type of soil, kind of livestock and managerial ability.
6. Technological changes in agriculture over a period of time make calculations difficult when economic benefits are studied on actual farms.
7. Direct benefits from soil conservation are often considerably different from the indirect benefits.
8. Economic returns are often different from the short and long time points of view.
9. Economic benefits depend upon whether measurements are in terms of income per farm or income per hour of man labor.

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Photo by Gordon S. Smith

A clamshell placing rip-rap on a sloped bank on the Henry Sicre. It was developed by Milton Drefel on his father's farm in Montgomery County, New York. Muskrat pelts are the main source of revenue, but skunk, raccoon, fox and mink have also joined the wildlife community.

Leaders in Soil and Water Conservation Honored

The following five individuals were elected as Fellow Members of the Soil Conservation Society of America and so honored at the 1953 Annual Meeting held in Colorado Springs, Colorado. This recognition goes to members professionally engaged in practicing, investigating or teaching soil and water conservation.

Walter D. Ellison. Outstanding authority on splash (*raindrop*) erosion and combatting techniques. Developed plans for hydrologic research project at Coshocton, O., provided leadership in development of 120,000-ton water-cycle lysimeters there. Organized conservation program for Navy (1948), later Navy's engineering consultant on soil and water problems. Prominent lecturer, writer, now writing book on soil erosion for McGraw Hill. Graduate civil engineer, product of western plains, native Missourian. Charter member SCSA, Washington, D. C. Chapter.

Morris E. Fonda. National president of the SCSA in 1951 and 1952, an outstanding leader in the conservation field—writing, speaking, and teaching the basic philosophy that all human endeavor is a product of the soil. He started his career as an estimator for the forest service in Michigan, and has successively worked with governmental, industrial and business groups to shape a national program that will be lasting and productive of maximum conservation practices. Mr. Fonda is now directing a mid-west company's program of training its representatives in agricultural conservation with special emphasis on grassland farming. He is a native of Michigan and has a natural gift for public speaking and leadership.

Russell G. Hill. Extension specialist in soil conservation at Michigan State College and executive secretary of the State Soil Conservation Committee. He is a native of Michigan and holds a B.S. degree in Horticulture and Education at Michigan State, was appointed extension specialist in game management there and remained in that position until accepting his present assignment. Mr. Hill has authored many bulletins and other publications on conservation . . . has served as treasurer and was also a member of the SCSA council.

Richard E. McArdle. Chief of the Forest Service, United States Department of Agriculture, with 29 years experience in forest and range conservation work. Forest management and protection was greatly accelerated under his direction as assistant chief with more than 60 million additional acres of forest, woodland and other watershed lands brought under organized Federal-State fire control programs. Tree planting and management was also stimulated under his direction. He has had wide experience over the nation as director of the forest and range experiment station. Mr. McArdle is a native of Kentucky and holds a Ph.D. degree from University of Michigan. He is a member of the Washington, D. C. Chapter of the Soil Conservation Society of America.

Arthur E. McClymonds. Recently retired as regional director of the Northern Great Plains Region of the Soil Conservation Service . . . is a native of Iowa, agronomy graduate of Kansas State College, where he remained after graduation to manage the college farm, later worked for an industrial firm on revegetating land damaged by mining. After World War I, he managed his own farm in California, later entered soil conservation work, directing research on crop production on irrigated land. He is a charter member of Soil Conservation Society of America and has contributed much to the current literature of soil and water conservation.

Honorary Membership in the Soil Conservation Society of America—for outstanding contributions in the field of soil and water conservation—was granted to the six individuals shown below.

Howard F. Barrows. Research director for the Austin-Western Company; searches out ways how heavy earth moving equipment can be adapted to conservation jobs. Has urged contractors and engineers to enter conservation business, is chairman of the SCSA Business and Organization Relations Committee. Mr. Barrows fathered the publication of the Society's first booklet, "*Down the River,*" and spearheaded an action program telling how soil conservation districts are using the publication. Works unselfishly because he believes sincerely in conservation in all its ramifications.

Malcolm M. Hargraves. Member of the famed Mayo Clinic who has turned his trained professional mind to the field of conservation with outstanding results. He is a member of the Izaak Walton League's national executive board, has appeared on many radio programs and elsewhere as a conservation leader. He also launched (1947) a game managers' short course, has seen its influence grow through annual meetings. Is in demand as a speaker on conservation, espousing the twin programs of education and action to bring about lasting conservation. Native of Massachusetts, received his M.D. degree at Ohio State University, Columbus, O.

Hon. Clifford R. Hope. The first public figure to show an intelligent interest in soil and water conservation, is co-author with Senator Arthur Capper of important legislation for farm cooperatives; also with Senator Jones of Texas on other important farm laws. He continually stresses the expansion of natural resource conservation as a necessary means of meeting long time needs. Mr. Hope is a native of Iowa, practiced law in Kansas, was speaker of the Kansas House of Representatives in 1927, went to Congress that year and has been there since. He is chairman of the House Agricultural Committee, and is known for his statesmanship and untiring leadership on conservation legislation.

W. W. McLaughlin. Former chief (now retired) of the Division of Irrigation Engineering and Water Conservation of the Soil Conservation Service, graduate civil engineer who, while teaching college chemistry, got into irrigation studies, then became interested in soil chemistry and physics research. Spent most of his life in the United States Department of Agriculture, pioneered in studies of injurious salts in irrigated areas. He is a native of Colorado, recipient of John Deere gold medal in 1940, and is the author of many bulletins, reports and manuscripts; also an inspirational leader and director.

V. C. Marshall. "Mr. Vernie" is recognized as the father of the soil conservation district program in Texas, now embracing 95 per cent of the land area. Personally organized 100 land owners into action to get proper laws enacted in 1939, then was drafted as the State Soil Conservation Board's first executive director, which position he still holds. Has seen conservation program save his state from disastrous erosion and the moral, social and economic degredation which follows. Finds time to manage his own farm, run two cotton gins and be a bank official.

George L. Peterson. Minneapolis editor whose broad interests in soil, water, wildlife and forests have been translated into action in many campaigns in the public interest. He espouses a national land policy embracing all conservation phases, strong backer of soil conservation districts. Former college teacher of journalism, graduate of Hamline University, weekly and daily newspaper experience. Does not know when interest in conservation began, but seems always to have felt a personal obligation to help save "*our resources.*"

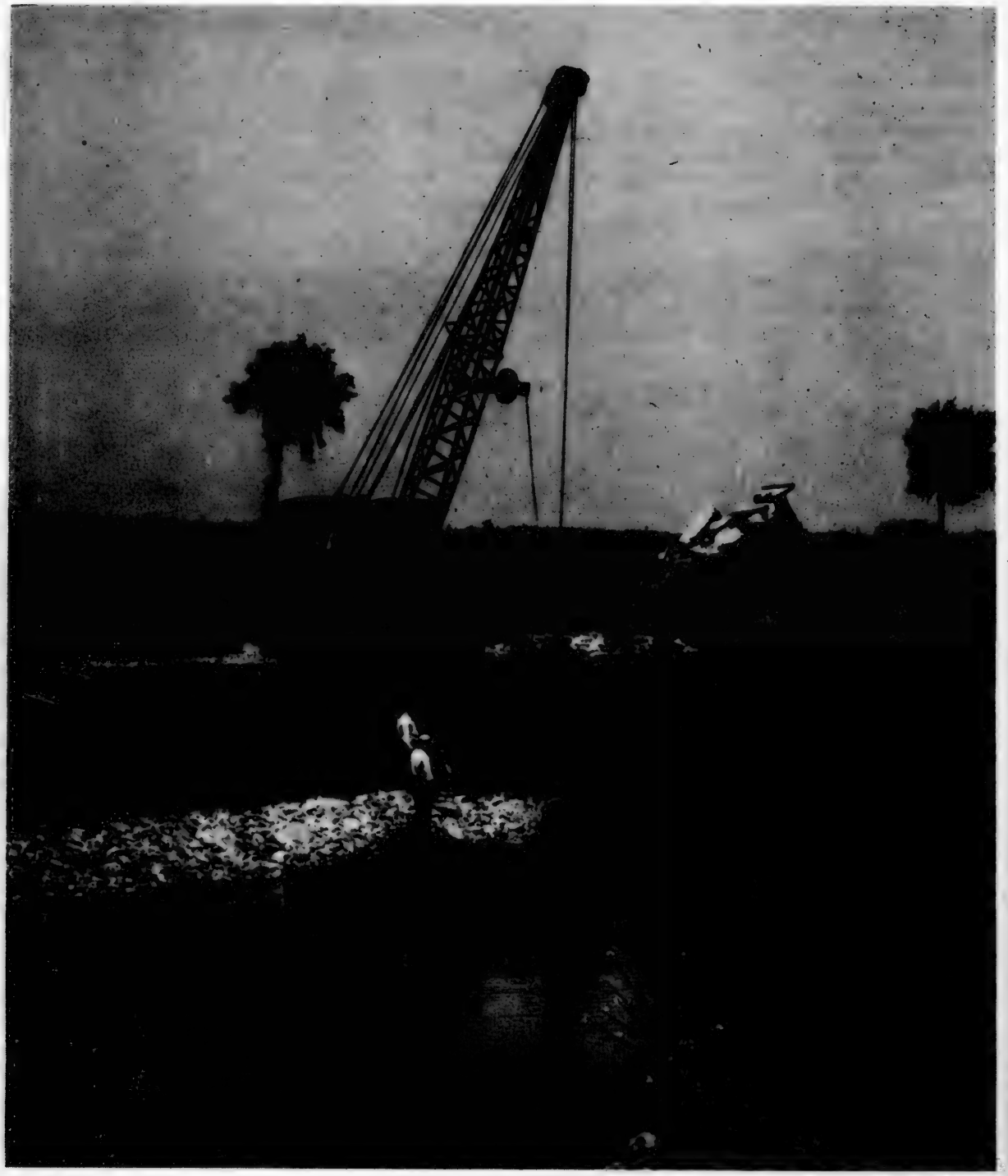

Photo by E. R. Keil

A clamshell placing rip-rap on a sloped bank on the Henry Simon's farm in Erie County, New York. This streambank construction job is on Buffalo Creek and is part of a complete watershed development program. Similar jobs are in operation on other streams throughout the country where streambank erosion is cutting into good farm land.

Report of Committee on Wetland Management

Here we offer the report of the Society's technical committee on Wetland Management, as presented at the 8th annual meeting, Colorado Springs, November 7, 1953. The report assures us of the growing activities of the Society in technical affairs, for the Wetland Management Committee has dealt realistically with one of the most controversial problems in modern land management. Climaxing more than two years' work, including on-the-land review, the Committee has produced a very constructive statement. The Chairman and the Editor will be glad to receive the comments of readers on the content of the report.

AT THE LAST Society meeting held in Buffalo, New York in October 1952, your Committee presented a progress report. Since that time, further consideration has been given to the problems confronting agriculture and wildlife interests concerning the use of certain kinds of wetlands.[1] A discussion was held by members of your Committee with members of the corresponding Committee of the Wildlife Society, in Washington, D. C. in March 1953, during the North American Wildlife Conference. It was agreed at that meeting that it is neither necessary nor practicable for the two Committees to achieve a common report, as had originally been suggested. The Wildlife Society Committee later made its final report at its Society meeting.

The entire Committee met for three days in Minnesota this past summer to work on our report. A field trip was held in conjunction with the meeting so that all members could familiarize themselves with the wetland problem of the prairie pothole country. This opportunity to work together enabled us to reach agreement on all phases of our current assignment. As a result, this report is recommended to the Society for its adoption.

Introduction

Many millions of acres of land were covered or saturated with water when this country was first settled. These we call wetlands. The relationships of water to soil have been subjected to great changes since that time. In some areas, water levels were raised by means of dams or dikes or, inadvertently, by filling the beds of water channels with the accumulation of debris from soil erosion. The area of wetlands was thereby increased. In many other areas, water levels were lowered by means of flood-control operations, ditches, tile drainage, and diversions. As a result of these actviities the amount of wetlands decreased.

Proper drainage makes possible a farm-management program that will better conserve and improve soils and make better crop use of the water that falls on the farm. Good farm drainage pays the farmer substantial dividends in the form of increased yields through better land utilization. It is now estimated that about 100 million acres of our most productive land, largely in the cornbelt area, are associated with drainage enterprises. There remains many millions of acres of fertile land, exclusive of irrigated lands, that can be improved by drainage.

Not all wetlands should be drained. Since drainage is expensive, the value of the anticipated benefits for both agriculture and wildlife should be carefully weighed against the cost; and the cost should include any resource losses such as waterfowl, fur animals, or valuable natural water storage basins.

According to the best information available, farm drainage generally does not cause excessive floods or droughts, change the pattern of precipitation, endanger the productivity of the soil, use up our ground water supply, or remove the useful capillary plant water from a mineral soil. Shallow surface waters are usually held to be unimportant in providing deep ground-water recharge. On the other hand, the effects of widespread drainage are imperfectly understood and there may be instances where the hydrologic cycle would be seriously affected.

Proportionately, a very small part of all farm drainage disturbs open water or marshes suitable for producing valuable crops of aquatic wildlife; in particular, certain kinds of waterfowl highly valuable for sport hunting. However, in some localities, widespread drainage may seriously affect valuable aquatic habitat. Thus, either of two wholly different crops could be produced on these lands. The trend has been to drain such areas to improve agriculture. Sections of the public interested in wildlife conservation and hunting would prefer that these areas remain in their natural state and be used for the production and protection of aquatic and other wildlife.

The Problem

On high-value agricultural lands capable of intensive cultivation without damage to the soil resource, little if

[1]See Appendix I at end of Report for Definitions of *Wildlife* and *Wetlands*.

any special attention to wildlife production can be expected. On lands which require special land-treatment measures, these often may be adapted to producing a crop of wildlife concurrently with good farming practices. Such wildlife production should be encouraged. On lands not suitable for cultivation or intensive grazing, forest and wildlife production with attendant watershed control benefits should be the paramount goals. Given an agricultural program—local or nation-wide—that is receptive to the inclusion of wildlife production, the problem of making such production attractive enough to the farmer to insure its inclusion in his plans and operations remains to be solved. The management of wetlands is an important phase of this problem, and presents an excellent opportunity for demonstrating the practicality and value of wildlife production on agricultural lands.

Waterfowl are outstanding examples of wildlife dependent upon wetlands for their continued existence.

Being migratory, their requirements must be considered from a continental standpoint, yet their place in the American scene is jeopardized by advancing land-use changes and the increasing demands of a growing human population for food and fiber. One approach toward management of the waterfowl resource would be a determination of how many ducks and geese are required, how much wetland habitat must be preserved and managed to sustain them, and the establishment of a program to effect the necessary dedication of lands for that purpose. This approach, however, appears to over-simplify the problem. The growing appetite of an expanding population for waterfowl hunting opportunities may well be insatiable. It is reasonable to assume, therefore, that if future demands for waterfowl hunting are to be met even in part it will be necessary to retain for waterfowl management purposes as much as possible of the present high-quality waterfowl habitat, to improve the moderate and low quality habitat, and to create as much new waterfowl management area as possible to offset unpreventable losses of natural areas. On the basis of known techniques in waterfowl management, there is little prospect of producing as many or more ducks for the future than now exist in a shrinking breeding range. Obviously, the extent to which the wetlands of the Nation can be devoted to waterfowl management, alone or in combination with other uses, is the key to the future welfare of the resource.

One great obstacle to the solution of this problem is the lack of clear-cut recognition of common interests by agricultural and wildlife groups. The problem facing these groups is to determine where a conservation program should recommend drainage of wetlands for crops production and where it should recommend the use of the land for waterfowl habitat. The solution of this problem rests on the development of a common philosophy and program for both the agricultural and wildlife interests.

First then, we must clarify the wetland situations where:

1. Drainage is feasible for agriculture but would result in the loss of valuable wildlife habitat.
2. Drainage is clearly feasible and beneficial to agriculture and not significantly detrimental to wildlife. In many of these cases, drainage will be beneficial to wildlife other than aquatic.
3. Drainage is not feasible for agriculture and the land should be used, developed and managed for wildlife crops. In some cases, the storage of water itself is of praramount importance to prevent salt intrusion for livestock, or other purposes.

The area of conflicting interests—agriculture and aquatic wildlife—is primarily limited to the first of the three. As an aid to solving this problem, the following points are suggested for consideration as a policy for the Soil Conservation Society on the use and management of wetlands.

Recommended Policy Statements

1. *Attitude Toward Drainage*

Drainage of potentially productive soils is an important tool of agriculture. Good farm drainage is an essential part of conservation farming in many areas. It is important that those concerned about wildlife conservation understand this fact. Moreover, conservation farming, including drainage, in most areas is generally beneficial to wildlife.

It is equally true that wetlands valuable for producing or sustaining waterfowl and other wildlife are a great asset to the country if kept in their natural condition or managed specifically for that purpose. It is, therefore, important that agricultural interests appreciate this fact and encourage drainage only as it contributes to a comprehensive conservation program.

We need understanding, helpful attitudes between agriculturists and wildlife specialists, and between landowners and sportsmen.

2. *Basis for Appraising Use of Wetlands*

Three factors are needed to appraise the best use of wetlands: (a) The potential productivitiy of the soils for agricultural use. This may be evaluated by soil analyses and the Land Use Capability system developed

by the U. S. Soil Conservation Service. (b) Engineering and economic feasibility. This must be determined by cost estimates based on engineering surveys. The costs should be carefully weighed against anticipated benefits. (c) Wildlife value. This item is exceedingly difficult to present in terms of dollars. Wildlife crops other than furs and commercial fishes are not marketed in the ordinary sense. However, it is very important that some means be developed to rate the wildlife importance of wet areas in comparison with their potential agricultural value. A recommended procedure for accomplishing this purpose is presented in Appendix II at the end of this report.

3. *An Inventory of the Wetlands of the United States*

There is an urgent need for a more complete inventory of the wetland areas of this country to implement future programs for agriculture and wildlife. Soil surveys are available for much of our agricultural land and are essential in evaluating wet soils. The Soil Conservation Service and various agencies of many states have for years been engaged in soil surveys of the farmlands of the United States which will show the location, nature, soil type, and extent of agricultural lands including wetlands along with other basic data required for a program of soil and water conservation. The United States Fish and Wildlife Service with the help of state wildlife agencies is making a survey of the present extent, condition, use, and potential productivity of wetlands for wildlife.

These surveys will contribute to showing the extent and nature of wetlands and aid in the determination of the best uses for them. They should be completed as soon as possible.

4. *The Private Landowner's Position*

The right of the private lanwowner to use his land as he pleases is fundamental in our free society provided that in so doing he does not infringe on the property rights of others. However, he has an obligation to care for his property in a manner that will best sustain its productivity and resources for future generations.

Private ownership, development and management of wetlands for the propagation, preservation and harvest of natural wildlife and plant crops should be commended and encouraged where this use is compatible with the farm enterprise. It should be recognized, however, that the landowner frequently needs counsel and assistance in such developments.

Attitudes toward the landowner's role in wildlife restoration and management need some modernizing. Natural breeding and feeding areas of some species have already been reduced to a critical level. The inevitable further decline in extent of waterfowl habitat and the accompanying and continuing increase in hunting pressure make urgent the preservation and improvement of as much of the remaining habitat as possible in keeping with the increasing demand for food and fiber production. Only the exceptionally interested and public spirited landowner will be willing to dedicate valuable lands for wildlife without some compensating recognition or income. In particular, he should be compensated for costs incurred primarily in the *public interest.*

5. *Public Assistance to Landowners*

Federal and state agencies working with landowners should point out the opportunities for all potential wetland improvement and management measures. Where two uses for marginal land are possible—drainage for agricultural use or development for wildlife — both should be considered. Where the area in question is highly useful to aquatic wildlife, public agencies should especially emphasize the desirability of preserving it for that purpose.

Subsidies of various kinds that encourage drainage, wildlife habitat improvement, flood control, and other phases of conservation are an established part of the relationship between government and landowners. They take various forms extending from the furnishing of technical advice to cash payments. Such subsidies should be used only where the work is in the public interest and would not otherwise be achieved.

Increased attention should be given by state and federal wildlife agencies in providing counsel and assistance to landowners for wildlife improvements on their wetlands. Agricultural extension agencies can help through their educational work. The soil conservation districts are collectively and individually one of the best mediums through which assistance to landowners on soil and water conservation work, including the development of wetlands for wildlife, can be effected. It is desirable for soil conservation districts to establish their own local policies pertaining to the use and management of wetlands.

6. *Public Ownership and Management of Waterfowl Areas*

In some areas, farm drainage of potentially productive soils is so important to a sound soil and water conservation program that it is frequently difficult to induce farmers to devote such areas to wildlife use at their own expense. An expanded program of public acquisition or leasing is needed in order to prevent such areas that are of superior quality for waterfowl from disappearing. Since the total waterfowl habitat is composed of public and private lands, with the latter collectively providing by far the larger amount, the urgency for acquiring

additional public areas will depend largely on the rate of further drainage of wetlands in private ownership. These trends should be studied in connection with recommendations for further acquisitions.

7. *Improved Use of Agricultural Lands*

Present agricultural trends are toward more intensive production on existing croplands through drainage, the prevention of erosion and soil depletion, and better farm management practices. Therefore, the drainage of many undeveloped wetlands, especially where the costs are high in relation to benefits, may not be using these lands for their more naturally adapted crops, including wildlife. Coupled with this, there should be increased emphasis on small impoundments of water on farms with attention to their wildlife production capabilities.

8. *Research in Wetland Management*

While research on many aspects of wetland management is now being conducted by agricultural and wildlife scientists, more is urgently needed. Agricultural research will unquestionably bring about continuing changes in farming practices affecting the use of wetlands. Biological research should be designed to insure corresponding progress in wildlife management techniques in this phase of land use.

9. *Education and Information*

Opportunities for developing and managing wetlands through soil and water conservation programs for agricultural and wildlife production should be taught in our colleges and schools through courses in conservation and land use. The concepts should be integrated into the fields of agronomy, soils, biology, engineering, and economics. In particular, it is of utmost importance that urban people and wildlife organizations be acquainted with the objectives of and need for drainage, and that the need for and benefits to be gained from the development of wetlands for wildlife be more clearly demonstrated to farmers and farm organizations. Only through the common understanding of the facts can better conservation be effected.

Future Work of Committee

It is recommended that the Wetlands Management Committee be continued as there are many problems in connection with various uses of wetlands which have not been considered and which should be studied as opportunity arises in order that the Society may be informed and be in a position to adopt policies concerning them.

Appendix

I. *Definitions as Used in this Report*

WILDLIFE as herein used is defined as: undomesticated vertebrate and certain invertebrate animals considered collectively. These include mammals, birds, reptiles, amphibians, fishes, mollusks (clams, mussels, oysters), and crustaceans (shrimp, crawfishes, crabs). Particular consideration in this report is given to those species that are dependent on or benefit from habitat provided by wetlands. Some are utilized for food and sport by man; others provide furs, skins, and other products of direct-sale values; some are important for controlling insects; others are of outstanding esthetic value. The waterfowl, shorebirds, marsh birds, and the aquatic fur animals are most spectacularly involved in the wetlands management problem, but many other groups utilizing wetlands are also of great importance to man.

WETLANDS as herein used are defined as: undeveloped lands so saturated or covered with water that land-use changes to permit development for agricultural, industrial, or domestic expansion are not usually possible without artificial removal of the water by drainage, stream channel enlargements, diking, filling, or other types of reclamation or flood control practices. This definition excludes (1) permanent water areas of all types that cannot be drained or otherwise reclaimed by practical means, and (2) agricultural lands under annual or regular cultivation where soils are too wet for efficient farming and where drainage or flood control is required to increase yields or facilitate farming operations.

II. *Procedure for Appraising Drainage Proposals*

The object of this procedure is: (1) to identify those publicly assisted drainage proposals that would, if carried out, seriously damage valuable aquatic wildlife habitat; (2) to inform the landowner(s) of the aquatic values of the area and the opportunities to manage it as wildlife habitat; and (3) to establish a means by which wildlife agencies will have an opportunity to review the proposal and to consider means of retaining wetland areas for wildlife production. The recommended procedure will be primarily useful where *all* of the interested agencies follow it.

Step I. *Physical Capabilities of the Area*

Determination should be made of the productivity of the area, if drained. If it is determined to be unsuitable for crop production (including livestock and timber), or its drainage is not necessary for farming efficiency, the proposal should not be recommended. If the proposed drainage is not ruled out by these determinations, then the state wildlife agency should be notified of this proposal and Step II undertaken. This will enable the wildlife

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Soil Erosion on a Fire-Denuded Forest Area In the Douglas-Fir Region

RICHARD S. SARTZ

Many foresters believe that soil erosion is not a problem on forest lands west of the Cascade Range in Oregon and Washington. There are good reasons why it may not be: high rainfall intensities are uncommon; most of the soils are not highly erosive; and the mild, wet winter climate is conducive to rapid regrowth of vegetation on denuded areas. Evidence in support of the belief, however, has been based more on uncontrolled observations than on actual study and measurements. To find out how much erosion might occur under one set of conditions commonly found in the region, a study was undertaken on a forest area that was denuded by fire in August, 1951. This is a report on that study.

THE BURNED AREA lies on a predominantly northeast-facing slope which overlooks the city of Portland, Oregon. The ground is steep and highly dissected by small and generally intermittent streams. The soils are derived from basalt. They are deep and heavy textured, but the surface soil is a "shot loam" containing many rounded, shot-size pellets. The profile is relatively stone-free. Most of the area had been burned in 1941 and all of it had been logged previously. Before the 1951 fire, however, the soil was amply protected by either living or dead plant material. The live woody plant cover consisted mainly of scattered red alder (*Alnus oregona*), willow (*Salix spp.*), and Douglas-fir (*Pseudotsuga taxifolia*) saplings, but a dense growth of bracken fern (*Pteris aquilina*) and annuals covered the ground. The fire destroyed the ground cover almost completely, leaving the soil bare except for unburned saplings, logs, and other debris remaining from the original Douglas-fir forest (Figure 1).

Annual precipitation in the Portland area is about 42 inches. Most of it falls as rain during the fall, winter, and spring months.

The Method

A study area was chosen that was representative of the steeper part of the burn, and five transects were marked off. The sites were chosen to sample different slopes and exposures. Three of them were on straight sidehill slopes and two ran across minor drainageways. Two of the sidehill transects were 24 feet long and one was 22 feet long; the drainageway transects were 22 feet and 34 feet long. The slopes on which the sidehill transects were located range from 39 to 83 per cent, the side slopes of the drainageway transects from 33 to 51 per cent.

The transects were established by selecting two stationary objects such as stumps, logs, or exposed roots between which a tape could be stretched and fastened at a convenient height above the ground. The tape was fastened in this way: The ring on the zero end was placed over a nail driven vertically into the log, stump, or whatever was used to mark this end of the transect; the tape was then stretched along the transect and clamped to a 1x2-inch stake which had been nailed to the object at that end. A 100-foot tape and a 4-inch C-clamp were used.

The stretched tape constituted a fixed line which was independent of changes in the ground surface. Using a standard leveling rod and a plumb-bob, the distance from the tape to the ground surface was measured at a number of points along each transect. Readings were taken at 2-foot intervals on the sidehill transects. The drainageway transects were read at 2-foot intervals on the side slopes and at each foot in the bottom sections. By taking a set of measurements in October 1951, and then again in May 1952, soil displacement over the greater part of one rainy season was determined. Actually, the first measurements were taken in September, before the first wetting rain had fallen and before the burned-over soil had settled. But at that time the surface soil was so loose and porous that it was felt these measurements would not serve as accurate reference data. Consequently, another set of measurements was taken on October 17, and this set was used as the base in determining soil displacement. By this time a total of 6.20 inches of rain had fallen since the fire, as recorded at the Weather Bureau Station in downtown Portland, six miles away.[1] The maximum 24-hour rainfall had been 1.15 inches. Total rainfall during the period between the October and May measurements had been about 32 inches. The maximum amount for a 24-hour period had been 2.15 inches, and the highest hourly rate .35 inch.

Richard S. Sartz is forester for the United States Forest Service with headquarters at Portland, Oregon. *The author is indebted to R. L. Hobbs for assistance in planning and carrying out all phases of the study and to Charles E. Hale for helping with the field measurements.*

[1]Precipitation measured at the downtown station was slightly higher than that caught by an 8-inch nonrecording rain gage which was set up two miles from the study area. Based on readings taken for 2½ months during the period of study, precipitation measured in the gage near the study area was two per cent less than that reported for Portland.

Results

All five transects showed measurable loss of soil (Table 1). Average losses ranged from .07 to .18 feet. The average for all transects was .12 feet. On three of the 80 points measured the May reading was less than the October reading. The differences at these points were considered negative in computing the averages. None of the negative values was greater than .04 feet, so they may be the result of either measuring error or deposition. With one exception, average soil loss per transect varied directly with percent slope. It was expected, however, that the effect of slope, as measured, on erosion would be partially obscured by differences in micro-relief and aspect.

The measurements were subject to a certain amount of error. The main sources of error were: fluttering of the tape in the wind; failure to rest the leveling rod on exactly the same spot each time; and indenting of the soil by the rod. Errors from the first two sources would tend to compensate. Actually, the figures are probably conservative estimates of soil loss for the whole season because there were visible signs that splash erosion (*1, 2*) had already occurred on October 17 when the base measurements were taken.

Other Observations

The study area was looked over several times through the fall and winter to observe visual changes that might have taken place. By mid-September a scattering of bracken fern had already come in to a height of 12-14 inches and some of the brush plants showed new sprout growth. By May 2, when the transects were remeasured, bracken, horsetails (*Equisetum spp.*), blackberries (*Rubus spp.*), and other weeds and brush sprouts were rapidly closing in.

At no time was there much evidence of surface runoff, but on October 17 we noticed a myriad of tiny pedestals on the ground surface—apparently the result of raindrop splash erosion; and colluvial deposits of fine material had begun to build up along some of the steeper slopes. After a heavy rain on October 22, the pedestals had disappeared and a few slight rills had formed in small drainageways. Water had ponded in one depression at the foot of a slope—but it was clear water, probably seepage from above. On December 7, after about 3.5 inches of rain had fallen during the previous week, depressions were full of water, but there was no further visible evidence that surface runoff had taken place. On May 2, to a casual observer the soil on the area would have looked little different from its appearance immediately after the fire. Close examination of the soil surface however, showed that many fine roots had been exposed on the slopes. A rill about six inches deep had also formed in the bottom of transect Number 4.

Table 1.—Summary of Erosion Transect Measurements

Transect No.	Slope	No. of measuring points	Difference between October and May Measurements	
			Range of Values	Average Value
	(percent)		(feet)	(feet)
Sidehill				
1	39	12	.00 to 0.20	0.09
2	83	12	.01 to 0.35	.18
3	68	13	[1].04 to 0.15	.07
Drain-ageway				
4	53[2]	18	.02 to 0.23	.11
5	64[2]	24	.04 to [3].30	.15
All	61	79		.12

[1]The minus sign indicates that the May measurement was less than the October measurement.

[2]Average of both side slopes weighted by number of measuring points on each.

[3]One difference of 1.73 feet, due to head-cutting in the bottom of the drainageway, was not included.

Figure 1. General appearance of burned area following the fire. The slope and condition are typical of the study area.

Discussion

The measurements show that there was appreciable sheet erosion on the area during the short period of the study even though there was little visible evidence that erosion had occurred. This finding is significant. It sug-

gests that soil erosion on fire-denuded areas of the Douglas-fir region may be much more common than is generally thought.

The almost complete lack of evidence of surface runoff leads to the conclusion that soil displacement was due largely to splash erosion from raindrop impact. Observations of soil pedestals and their subsequent disappearance, and the later appearance of exposed roots support this conclusion. The absence of surface runoff from denuded soils on steep slopes at first seems surprising. There is a reasonable explanation, however: after burning and exposure, the capacity of the soil to take in water was still sufficiently high that no surface runoff resulted from the moderate rainfall intensities experienced during the period covered by the measurements. The natural characteristics of the shot loam soil to resist puddling probably contributed to the maintenance of a satisfactory infiltration capacity in this particular case.

Growth of vegetation during the first year after the fire prevented further measurements. It is believed, however, that the vegetation which grew during that time provided effective control against further sheet erosion on most of the area. There were some bare spots still susceptible to splash erosion, but soil movement probably was restricted to the spots themselves because of the shielding effect of the surrounding vegetation.

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agency to begin an evaluation of the wildlife values of the area at once if they desire.

Step II. *Feasibility of Construction*

Engineering surveys, designs and cost estimates of the job should be completed.

If the proposal is physically not feasible, all parties concerned will be notified. The landowners should then be advised on ways of managing the area for wildlife. If the proposal is economically feasible, then Step III should be undertaken.

Step III. *Evaluation of Vegetative Cover and Wildlife Values*

If the land proposed for drainage does not involve a change in land use, or if it does not support aquatic or wet-soil vegetation, the drainage will not likely damage aquatic wildlife and the proposal may be recommended.

If the land proposed for drainage is an aquatic area, arrangements should be made for an appraisal of its wildlife habitat value by qualified wildlife technicians if this has not already been done.

If the findings show that the area has no, or limited, value for important aquatic wildlife or if drainage would improve conditions for wildlife, the drainage proposal may be recommended. If the area proves to be of particular value to the landowner for wildlife production, or is so useful to aquatic wildlife that its retention as aquatic habitat is a matter of public interest, the landowner should be advised of this fact, encouraged to leave it undrained, and either (1) manage it himself as a wildlife area; (2) make it available to a public agency or private person or group to manage as a wildlife area; or, (3) sell or lease it to a public agency or private interest to manage as a wildlife area.

All interested parties should have a reasonable opportunity to deal with the landowner and work out any possible mutually-agreeable arrangements.

Step IV. *Resolution of Drainage Proposal*

If satisfactory arrangements are made for using all or part of the lands in question for wildlife production, the drainage proposal shall be dropped or modified accordingly.

If no satisfactory arrangement can be made for devoting the lands to wildlife, the drainage proposal may be carried out providing it is agriculturally sound and economically feasible, and the owner has agreed to the costs.

B. D. BLAKELY
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Book Reviews

VEGETATION AND WATERSHED MANAGEMENT *by* E. A. COLMAN. *The Ronald Press Company, New York, 1953. 412 pages, 37 illustrations, 6 maps. $7.00.*

During recent years, public interest in the protection and management of watershed lands has grown at a rapidly accelerating pace. This interest has naturally led to corresponding demands for adequate knowledge on how to improve watersheds. In response to this need, the Conservation Foundation asked Dr. Colman to review available information and to prepare a reference work on the relation of vegetation to water yields and watershed management. This book is the result. It is a first-class contribution to knowledge, and should go a long way toward filling the present gaps in readily available information.

In his Foreword, Dr. Fairfield Osborn has indicated the purpose and scope of this book so well that his statements deserve direct quotation:

> Dr. Colman's book is, in effect, a comprehensive survey of the control, by vegetative means, of water on the land, beginning at the point where precipitation strikes the foliage, and ending with the influence of management practices on streamflow, on channel stability, and on ground-water storage. Part of this discussion of vegetation management deals with its use as a technique in flood control.

The book deals with structural control of water only incidentally. It does not go into hydrologic analyses, and it treats microclimate and forest influences only as they bear on the main subject. It does not go into the management of vegetation for crops other than water. All of these features are good: they mean that the book is focused on watershed management, without unnecessary diffusion into related fields.

The book is divided into three main parts. The first, "*Water Yield and Its Control*," is a general presentation of the watershed management problem. The second part, as indicated by its title, is intended to deal with the principles of water yield control. It actually covers more ground: aside from outlining principles, Part II goes into the relationships of several methods of water control, especially the relation of vegetation and structures. The third and final part of the book is devoted to applying the principles discussed in Part II. This is done by first outlining the vegetation regions of the United States; then by discussing research work that has been done by a variety of agencies, on both cultivated and noncultivated lands; and finally by presenting detailed discussions of alternative kinds of vegetation for watershed management, with special attention to four broad classes of land-management problem: croplands, fire, grazed lands, and tree-covered lands.

The last chapter of the book, "*The Opportunities and the Challenge*," might be expected to contain recommendations for the better management of watershed lands. Although these are implied in earlier chapters, they are not expressed as prescriptions for management at any place in the book, even including the final chapter. This fact does not reflect upon the book or its author, however; rather, on the present state of the art of watershed management. Up to now we have only begun to bring together the results of research; in the future, it will be more and more necessary to express these facts as recommendations for applied land management.

With these very minor reservations, Dr. Colman's book is an excellent reference work for people interested in watershed management. It can be expected to have a widely varied audience, including engineers, agronomists, and other technicians as well as students and teachers.

—H. G. WILM, *Syracuse, New York*

THE ECONOMIC ORGANIZATION OF AGRICULTURE. *By* THEODORE W. SCHULTZ, *Professor of Economics, University of Chicago. McGraw-Hill Book Company, Inc., New York, 1953. 374 pages. $5.50.*

Readers of the JOURNAL OF SOIL AND WATER CONSERVATION will find this book an interesting development of Professor Schultz's earlier work, *Agriculture in an Unstable Economy*. The effect of growth and development of the general economy upon agriculture is one of the main topics of the book. The effects of population increases, income increases, new production techniques, and changes in consumer habits are all considered in their effect on demand for agricultural products. The author's conclusions on agriculture as a declining sector of the economy, trends in agricultural research, and the relative importance of land to other production factors are strengthened by a wealth of data which were formerly unavailable to research workers. The work on stability of inputs in agriculture is another example of new information contained in the book.

After discussing the position of agriculture relative to the economy as a whole, Schultz turns to the problem of making adjustments which will help agriculture fit smoothly into the gradually developing economic system. He believes that too little effort is being made to induce economic development by discovering new production techniques, making better economic information available, and accumulating more capital. More work is also needed in developing the labor market. Plans for helping workers migrate to areas where they will be more productive are discussed. The author

stresses the importance of rural social and economic conditions to the nations as a whole, since so many rural people migrate to cities. A well educated rural population is a great aid to the future productivity and welfare of the nation.

The subject of land reform and the family farm is also discussed under the subject of the factors of production. Problems of uneconomic-sized farms are considered, along with some plans for improvement. Yield instability is an important factor to the individual farmer, though not to the nation as a whole. Some areas where yields are very unstable might be better abandoned or owned by the public. Many insurance schemes also help to combat yield instability.

The Economic Organization of Agriculture makes interesting reading for anyone interested in agriculture, whether he is trained in the technical fields or in economics or sociology. Readers who are not trained in economics will be pleased by the absence of technical economic terms and the usefulness of the information presented. Economists and sociologists will find it especially interesting from the standpoint of welfare economics.

—W. H. HENNEBERRY, *Urbana, Illinois*

RIVER ON THE RAMPAGE. *By* KENNETH S. DAVIS. *Doubleday & Co., Inc., Garden City, N. Y. 1953. 217 pages. $3.00.*

The rain that brings a lush green to the Kansas prairies in early summer and checks the hot wind, which otherwise parches and cracks the earth and raises swirls of dust to obscure the sun and stifle life, turned destroyer in July of 1951. In the wake of the raging waters of the Kansas River and its tributaries were left 45 deaths, over 2,000,000 acres of rich Kansas-Missouri Valley farmland flooded, 45,000 homes destroyed or damaged, and an aggregate property destruction that has been estimated as high as $2,500,000,000 —the costliest flood in the nation's history.

Kenneth Davis' account of this major catastrophe is a dramatic and absorbing story of the flood, a stimulating analysis of the region's water problems and programs, and a somewhat disorganized collection of views and opinions on an assortment of related issues. Written during the aftermath of the flood from the vantage of Manhattan, Kansas—which alone suffered $20,000,000 damage—Davis' work is a persuasive argument for unified valley development and a strong indictment of power struggles among federal agencies, the subversion of politics to special interests, and the general indifference to the need for water conservation.

SOME OBSTACLES TO SOIL EROSION CONTROL IN WESTERN IOWA. *Iowa State College Research Bulletin 391. Ames, Iowa, 1952.*

A research program being carried out by the Iowa Agricultural Experiment Station and the Bureau of Agricultural Economics attempts to: (1) discover the kind of obstacles to erosion control measures and (2) develop ways and means of overcoming these obstacles. This bulletin is mainly concerned with the first phase of the program.

The methods used in the study should be helpful to other research workers and also to extension agents and conservationists who are trying to help farmers put more erosion control measures into practice. An area was selected in western Iowa where farmers had not controlled erosion to the extent recommended by the soil conservationists. The study then proceeded to find out reasons for the "gap" between present and recommended erosion control practices. Farm plans designed to reduce erosion to a "permissible" rate were prepared for each farm in the study, and on farms where erosion exceeded this rate, operators were asked to give reasons why they were unable or unwilling to follow such plans.

The four major obstacles (selected from a list of 15) were found to be: (1) changes in farm enterprises, mainly increasing the number of livestock; (2) rental agreements and lack of cooperation from landlords; (3) mortgage indebtedness and high operating and living expenses; and (4) short expectancy of tenure on farm. Actual erosion losses were much higher on farms where these obstacles were named than on other farms in the study.

The bulletin also contains suggestions for overcoming the obstacles from operators who had successfully controlled erosion on their farms. They include methods for obtaining additional capital, efforts to reduce uncertainty of livestock production, better rental agreements, and amortizing farm loans over a long period of time.

This publication is a result of a thoroughly planned and well conducted research project. The second phase of the project, that of developing ways and means of overcoming obstacles to erosion control, should be even more helpful than the first. Discovery of the obstaeles, however, represents an important first step in combating erosion.

—W. H. HENNEBERRY, *Urbana, Illinois*

YALE CONSERVATION STUDIES. *Yale Conservation Club, New Haven, Connecticut. Vol. 1, 1952, 84 pages; Vol. 2, 1953, 100 pages.*

The Conservation Program established at Yale University a few years ago under the direction of Paul B.

Sears is certainly one of the most promising educational developments in the study of man and his natural environment. Granting a degree of Master of Science in Conservation, the Yale Program—if the essays of Yale graduate students collected in the volume under review are indicative—is a broadly-conceived undertaking which finds time to emphasize the social and ethical aspects of resource use as well as the more conventional technical considerations.

Although these reports are predominantly student-written, Volume 1 opens with a brief analysis of the need to safeguard our remaining wilderness by E. W. Sinnott, dean of the Yale Graduate School, and concludes with an essay by Paul Sears on the conflicts of interest in conservation. The intervening ten reports cover a wide range of topics, including a good discussion of the goals of resource allocation by Gordon Loery, an interesting survey of farmer attitude toward conservation by Richard Lingenfelter, summaries of panel discussions, and articles on private wood-lot forestry, demography, sewage sludge, wildlife, and the like.

A similar diversity of projects is found in the second volume, with an article entitled "Ecology, the Poetry of Science" by Susannah Coolidge immediately preceding a discussion by Owen Beenhouwer on predicting growth potential in beef cattle. Possibly the most ambitious undertaking is the report of Robert Teeters, "*The Effect of Population Growth and Rising Levels of Living on Resource Drain in the United States.*" Teeters appreciates the difficulties in the way of devising satisfactory indexes of the "level of living" and "drain on resources" but makes good of secondary source materials. If his conclusion seems abrupt and tentative, as indeed it is, it should be remembered that much work remains to be done in this field. We must know more about the nature of economic growth and the effects of technology upon resource utilization, as well as refine our statistical techniques, before we can hope for a conclusive answer to this large and important question.

Extra-market problems of resource utilization are discussed in provocative notes by Paul Shepard on National Parks, Oakleigh Thorne on the New York Forest Preserve, and Robert Perkins on natural areas, while Harry Doehne writes on "*Land Reclamation with Alluvial Fill*" and Gordon Loery is the author of a well-documented and persuasive study entitled "*Protecting the Watershed—A Community Job.*" Four outside authors are represented in Volume 2: Tom Gill, Executive Director of the Charles Lathrop Pack Forestry Foundation, provides the Forward; F. P. Cobb of the British Colonial Administrative Service contributes the guest essay; Jane Collier of Barnard College is represented by the undergraduate prize essay, "*The Small Farmer and Soil Conservation;*" and Paul Sears' article, "*An Ecological View of Land-Use in Latin America*" is reprinted from CEIBA.

The student essays in these volumes are brief and hurried, and sometimes opinions tend to outdistance facts, but they are gratifying evidence of the intellectual ferment produced by the Yale Conservation Program —a ferment that is the essential ingredient of both learning and scientific advancement.

L. G. HINES, *Hanover, N. H.*

INFLUENCE OF FORESTS ON SNOW IN THE PONDEROSA-SUGAR PINE FIR ZONE OF THE CENTRAL SIERRA NEVADA. By JOSEPH KITTREDGE. *96 pp. Hilgardia (University of California Berkeley, Calif.) Vol. 22 No. 1, March 1953.*

Kittredge's publication reports on one of the very few systematic studies of snow made in the Sierra Nevada of California. It contains information that can be of real help in planning timber harvesting operations in this area where water yielded from the snow pack is of very great value.

The study was made in the mixed conifer zone of the Central Sierra Nevada, at elevations between 5,000 and 6,500 feet. Accumulation and depletion of the snow pack were measured under ten kinds of cover conditions, ranging from open meadow to dense forest stands. The study was carried on from 1934 until 1941. Neither water yield nor streamflow was measured.

The forest cover held away from the ground between 13 and 27 per cent of the year's snowfall. The lowest interception loss was found in the least dense stands, sugesting that the heavier the forest is cut the more snow will reach the ground. One may have some reservations about this, although there is little evidence on which to base them. It is possible that some of the snow caught on the crowns melted and dripped from the trees, passing through the snow and into the soil. One reason for suspecting that this may have happened is because evaporation from snow in the crowns appears to be so much greater, in this study, than evaporation from snow on the ground. However, regardless of the facts in the case, it is quite clear that snow pack on the ground increases as openings are made in the forest up to widths somewhat greater than the heights of the trees.

Openings made by cutting in the forest accumulated more snow than did much larger open areas, such as meadows. Kittredge suggests that the openings trapped snow that, without them, would have reached the

ground to leeward. This suggests the possibility of trapping snow in strategic areas by cutting the forest to produce groups of openings. It is likely that snow piled up more deeply in forest openings than in large open areas would melt more slowly, which would be advantageous in prolonging water delivery to streams.

Contrary to findings in the Wasatch and Rocky Mountains evaporation from the snow pack was found in this study to be quite small. It varied from .01 inch to 1.5 inches, with large open and cut-over areas showing the highest quantities. Interestingly enough, evaporation was lower late in the melt season than early. This was ascribed to the fact that the snow temperature remained at 32° while the air temperature above it rose as the season progressed. Because the air here is prevailingly moist during late spring the dew-point is usually 32°. When this condition holds, water would condense on the snow rather than evaporate from it. This finding is important, for it suggests that delaying snow melt or slowing melt rates does not result here in increased evaporative losses from the snowpack.

The rate of snow melt, expressed in inches of water per day, was not much affected by type of cover or cutting. However, because forests with openings accumulated more snow on the ground than closed forests or large meadows, snow persisted longer on the ground in the openings made in the forests. Here again is a suggestion that timber harvesting methods that leave rather large openings are advantageous in accumulating snow and causing it to release its water over the longest period. Delayed delivery of snow water to the soil means delayed delivery of water to streams, and increases in the most valuable flows—those of summer and fall.

Kittredge concludes that "clear cutting in small groups should both yield the most water and prolong the summer flow. Strip cuttings might also give good results if the clear cut strips are narrow, if they follow, as far as possible, the contours, and are oriented east and west rather than north and south. The proportion of the total area that is cut clear in groups or strips, provided they are not much wider than the heights of the trees, should be as large as consistent with the reservation of sufficient areas of uncut timber between to provide screens and be windfirm."

A word of caution regarding application of the findings of this study: The findings apply specifically to areas in the Sierra Nevada where the maximum water equivalent of the snow pack varies from a low of three to six inches of water to a high of perhaps 30 inches. In areas where the snow pack is considerably greater one would expect forest treatments to have greater effects, more like those observed in the years of this study that brought unusually great quantities of snow. With respect to the question of application, it is unfortunate that more information about the study areas is not provided in the publication. Aerial or ground photographs, or maps, of the several forest stands would have been extremely valuable to the reader. With the brief written descriptions of the study areas that are provided, the reader does not have all the information needed to interpret the research results in terms of forest conditions as they are found in particular places.

Kittredge's study has provided important clues as to the kinds of effects we can exert, by timber management, upon snow accumulation, evaporation, and melt. No studies yet undertaken have been carried far enough to measure the water yield of snow pack areas in which timber has been cut in one way or another. Only when studies have been made in which streamflow is measured will we be able to appraise quantitatively the possibilities of managing the snow pack.

—E. A. COLMAN, *Berkeley, California*

GAME BIRDS OF COLORADO. EDUCATION DIVISION *Colorado Game and Fish Department, Denver 3, Colorado.*

This attractively illustrated and popularly written booklet has been prepared by the education division of the Colorado Game and Fish Department. An excellent black-and-white photograph of each of the game birds is accompanied by a short factual statement about the bird's predominant coloration, markings, and the pertinent points of its life habits.

The booklet stresses the close relationship which exists between the well-being of these game birds and the use we make of our lands. In most instances, living space, food, and shelter constitute the basic requirements for sustaining satisfactory numbers of game birds.

Although *"Game Birds of Colorado"* pertains particularly to species of that state, many of these birds are found in other states. For that reason, the booklet should be helpful to many persons. Copies may be obtained by writing to the Colorado Game and Fish Department, 1530 Sherman Street, Denver 3, Colorado.

THE CONSERVATION YEARBOOK 1953. *Second Annual Edition. Edited by* ERLE KAUFFMAN, *The Conservation Yearbook, 1740 K Street, N.W., Washington 6, D. C. 324 pages. 1953. $5.50.*

The 1953 edition of the Conservation Yearbook, edited by Erle Kauffman, revised and enlarged is now available. It contains 324 pages of facts, figures and names of American people prominent in the conservation movement. The book also lists federal, state, regional and local conservation agencies and organizations concerned with resource development.

Free and Inexpensive Materials for Conservation Education. DR. RICHARD L. WEAVER, *P. O. Box 2073, Ann Arbor, Michigan. 15 pages. 1953. 10 cents.*

This is an excellent bibliography of source references and materials available to persons in education work. The supplementary classroom aids contained in the publication are applicable in grades one to twelve, and was compiled from state and federal agencies, universities, business, and industry.

Other Useful Publications

American Cyanagrams. PETER HOHAN, *Editor. Published by Agricultural Chemicals Division, American Cyanamid Company, 30 Rockefeller Plaza, New York 20, New York.*

The Middle East Journal. HARVEY P. HALL, *Editor. Published Quarterly by the Middle East Institute, Washington, D. C. Single Copies $1.50.*

Communal Land Tenure. *By* SIR GERARD CLAUSON. *An FAO Publication, International Documents Service, Columbia University Press, 2906 Broadway, New York 27. 60 pages. 1953. 50 cents.*

Conservation Film

Waters of Coweeta. *16 mm., sound, in color. 16 minutes. Released 1953 from USDA, Forest Service,* SOUTHEASTERN FOREST EXPERIMENT STATION, *Asheville, N. C.*

This documentary film shows the results of 20 years of watershed research on the Coweeta Hydrologic Laboratory. This field laboratory, located on Coweeta Creek in the Appalachian Mountains of North Carolina, is made up of individual small watersheds. Each small watershed draining into Coweeta Creek is an experimental area or "*guinea pig.*" The behavior of each stream before and after treatment tells the story of each treatment or use.

In order to record the effect of different treatments on the water regime, a complete network of rain gages, deep wells, weirs, automatic level recorders and other meteorological instruments have been installed.

The film vividly illustrates the effects of different uses of mountain land on the quality and quantity of streamflow of mountain streams. The results of clear-cutting, mountain agriculture, woodland grazing, and mountain logging are effectively illustrated.

It is an informative film which should be of interest to lay audiences and technicians alike. It should be of interest to students, teachers, engineers, and foresters—the type of visitors who normally come to Coweeta to find out first hand the results of this research on our water suppy.

—SIDNEY WEITZMAN, *Elkins, West Virginia*

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E. A. COLMAN, *U. S. Forest Service*

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Irrigation Development and Public Water Policy

ROY E. HUFFMAN, *Montana State College*

Incorporating major changes of the last quarter century, this new work presents a full account of the socio-economic aspects of irrigated agriculture and public water policy in the U. S. Explains the problems in financing, planning, organizing, and operating irrigation projects, and offers criteria for evaluating water resource programs. Underscoring the need for sound, far-sighted irrigation policy on a national, regional, and local level, it assesses irrigation's role in small farm projects, river basin development, etc. *19 ills., 336 pages.* **$6.50**

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FIELD NOTES AND COMMENTS

Pan American Union Makes Annual Conservation Award

Each year for the past five years the Pan American Union has made an award to a Latin American for outstanding accomplishments in conservation. The award, made by a panel of judges selected by the Pan American Union, amounts to $2,000, granted in the form of a scholarship, a travel grant, or for the publication of significant conservation material.

This year the panel, meeting on September 15, granted the award to Mr. Francisco Tamayo, former Director of Forestry in Venezuela. A major factor in selecting Mr. Tamayo from the list of ten candidates was his unusually successful accomplishment in relieving a serious overgrazing situation. This action involved the removal of 35,000 sheep, resettlement of the people in more advantageous locations, and restoration of the severely damaged watershed areas.

The panel of judges for 1953 consisted of Dr. Hugh H. Bennett, past-president, Soil Conservation Society of America; Ellis Clough, Foreign Agricultural Service; Bernard Frank, Forest Service; Fred Packard, National Parks Asociation, and Alexander Wetmore, Smithsonian Institution.

Conservation Council of Business Organized in Michigan

A new organization, to be known as the Conservation Council of Business, Industry and Finance, has grown from a series of conferences held in Michigan under the chairmanship of Dr. Stanley A. Cain, chairman of the department of conservation of the University of Michigan.

A constitution and by-laws were adopted at the most recent conference, held May 19-21 at Hidden Valley, Gaylord, Michigan. The organization will be completed with election of officers next spring.

The Michigan conferences, including the recent one at Hidden Valley, have been sponsored jointly by the Michigan Department of Conservation, the National Association of Manufacturers regional office, the Michigan Chapter of the Soil Conservation Society of America and the University of Michigan.

Third National Land Judging and Land Appreciation School Scheduled

Oklahoma City will again play host to farm youth and adults from at least 20 states at the third annual national land judging contest and land appreciation school scheduled for April 29-30, 1954.

Cash awards totaling $1,800 will be paid winning 4-H and FFA teams and individuals. This year for the first time regional awards amounting to $40 will be paid top FFA and 4-H in each of the four regions of the country. Top team in each division will receive $50. This will be separate judging divisions for adults, with women competing in a class of their own. Plaques and trophies go to adult winners.

The land appreciation school, sponsored by the Oklahoma Publishing Company, has spread to several other states and to a few foreign countries. It is developed on the theory that land can be judged just as cattle, and boys are taught to look for and recognize certain physical characteristics of the soil, just as judges do in livestock. Further contest information may be had by writing Edd Roberts, Extension Soil Conservationist, Stillwater, Oklahoma, or Sandy Saunders, WKY, Oklahoma City.

Five Conservation Leaders Receive Awards for Distinguished Service

Five of the nation's top conservationists—The Assistant to the President of the United States, an educator, an editor, and two businessmen—have been named as winners of The American Forestry Association's Annual Conservation Awards for 1953.

They are:

Sherman Adams, The Assistant to the President, former Governor of New Hampshire and well-known New England forester and lumberman, for his work in helping to frame and secure the enactment of key legislation in connection with forest management in New Hampshire.

George L. Drake, vice president of the Simpson Logging Company, Shelton, Washington, and president of the Society of American Foresters, for his leadership in cooperative forestry between public and private agencies.

Thomas V. Downing, assistant state supervisor of agricultural education, State Department of Education, Richmond, Virginia, for his work in pushing youth education programs in forestry and related subject in Virginia as well as other southern states.

Ernest H. Linford, chief editorial writer, The Salt Lake Tribune, Salt Lake City, Utah, for his work in pushing the Tribune's aggressive conservation policies and for over 100 editorials on all phases of western conservation endeavor that have been published widely throughout the United States.

P. H. Glatfelter, president, the P. H. Glatfelter Company, Spring Grove, Pennsylvania, for his

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pioneering work in the 20's and since, in impressing the importance of sound woodland management on woodland owners and farmers providing pulpwood to his company and others.

Presentation of the awards were made at the American Forestry Association's Fourth American Forest Congress held in Washington, D. C., October 29-30, where upwards of 1000 leading conservationists and citizens gathered to frame a forest policy program for the nation. Each winner was presented with an inscribed walnut plaque and a life membership in The American Forestry Association.

Nash Conservation Awards To Recognize Professionals

Creation of an annual $5,000 awards program for professional contributions in the field of conservation of natural resources was recently announced by George W. Mason, president and chairman, Nash-Kelvinator Corporation. Recognition will also be given to non-professional contributions.

The nationwide program will be known as "Nash Conservation Awards." Ten cash awards of $500 each will be presented to ten professional conservationists, working in education, research, administration or enforcement, in any field related to soil, water, forest, fish or wildlife conservation. In addition, ten awards consisting of plaques and citations will be given to non-professionals whose contributions to conservation have been performed as acts of good citizenship.

"The automobile industry has a stake in conservation because so much of the enjoyment of the outdoors depends upon the automobile," Mason said. "Nash has produced several films on hunting and fishing which have been shown to millions of people throughout the country. The interest of sportsmen has also led us to develop many special adaptations in our cars to make them of greater usefulness to sportsmen, campers and tourists."

Nominations for awards are to be made by newspaper rod-and-gun and conservation editors, rod-and-gun clubs, and public and private conservation agencies. Final selections will be made by the Awards Committee, which for 1953 consists of Ed Dodd, creator of Mark Trail; Pieter Fosburgh, editor of the New York State Conservationist; Johnny Mock, outdoors editor of the Pittsburg Press; Alastair MacBain, chief of Information Bureau, U. S. Fish & Wildlife Service, and Michael Hudoba, Washington correspondent and authority on conservation legislation.

Leveling Land for Conservation An Important Practice in Utah

The best way to keep soil from eroding is to level the land.

Where there is more rain than the crops need, men have to provide for getting the extra water off the land before it drowns the crops, water-logs the soil, or stops the job of planting until the summer is too far gone.

An irrigation land, near Antimony, Utah, filling with water. On flat land water flows so slowly that it does not move any soil. This is a hillside farm, and each land, 30 feet wide and curved to fit the hill, is about one foot below the next one.

The nearest to level that can be allowed in such humid places is the occasional dikes on contours that are made to interrupt the long steep slopes of rolling country. And these dikes, usually in the form of broad-base terraces, cannot be put on level contours, but on slopes. The slope of a terrace needs to be flat enough to keep the water from running so fast that it will move any soil, and steep enough to definitely carry all the water off the field. The channel above the terrace may be cut down into the B horizon on purpose to drain the soil better.

However, where there is less rain than plants will use, men can make land exactly flat, so there is no chance for any erosion. And they can put a dike around each piece of land so that all the water that is put on stays there for the crops. They prevent water damage by not putting on a damaging excess.

The Egyptians in the Nile valley have irrigated this way for the last 6,000 years that we have record of. And their agriculture supports a population density of more than 1,000 people per square mile.

Now, there are still lots of irrigators who do not level their land flat nor use dikes to control the water. They are among us who have come from high rainfall countries, or perhaps it was our fathers or grandfathers who came. We have an inborn fear of too much water on our fields, akin to our inborn fear of fire. We can hope that after a few generations, such prejudices against flat lands can be filtered out of our blood.

The first irrigators in the Mountain West came from the eastern part of the United States, where there is usually too much rain. Almost before they made their irrigation ditches to supply their fields with water, they made waste ditches. And we still have them.

Erosion by irrigation water on a field near Panguitch, Utah, that slopes about two feet in 100 feet. Every furrow is a gully.

A good farmer told me, "Sometimes I think that our wasteways do more damage than they do good. A man may know that he should get up and change the irrigation water onto a new land, but he will excuse himself for another hours sleep, knowing that the extra water will go into the drain."

We have a whole list of means that the poor farmers who live where it rains a lot have to use to hold their soil from eroding such as contour plowing, grass planting, winter cover crops, grassed water-ways, etc.; and all because their chronic excess of water precludes their leveling their land so it cannot erode. Being able to level their land to stop erosion, irrigation farmers have complete freedom in how they manage their land, and it will still stay where it is. They can bend all their efforts to treating their soils to increase crop yields without a thought or worry of losing their soil.

Water cannot erode soil from level land.

—JUSTIN M. SMITH, *Delta, Utah*

Oil Capital Backs Range Conservation

The Chamber of Commerce of Midland, Texas, is a live-wire organization, boosting the *"Capital City of the Permian Basin"* in the best chamber of commerce tradition. The Permian Basin, for the unitiated, is a geologic complex underlying parts of southwestern Texas and New Mexico, supporting one of the richest oil-producing areas in the world.

Midland, a metropolis of 35,000 population, is headquarters for more than 400 oil companies operating in this area. Skyscrapers, big money, and high-pressure deals feature the Midland business community.

But the Midland country is basicly a ranching country. Oil may be the mark of wealth, but cattle and big pastures are the badge of substantial respectability. And Midland people have not forgotten their native traditions.

By the summer of 1953 the Midland country had endured a 3-year drought as severe as any that brought forth recent governmental "drought disaster" measures. In the midst of this emergency, the Midland Chamber of Commerce spoke out forcefully to direct ranchmen's attention to the preservation of the basis of their own industry—their range lands. Its action pointed out that the real productive capacity of their ranges lay in their grasses and soils, not in their oil wells.

When the soil conservationist assisting the Martin-Howard Soil Conservation District called the attention of chamber officials to the problem of range depletion

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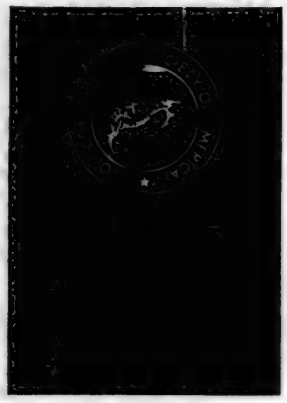

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aggravated by the drought, they promptly called into session their own agriculture committee and officers of the county livestock association. There the situation was thoroughly canvassed. A resolution requested the Soil Conservation Service to survey effects of the drought on ranges and suggest remedies.

Midland Chamber Publishes 12-Page Booklet

The Chamber of Commerce prepared and published a unique 12-page booklet calling attention to the drought situation. It asked ranchmen to cooperate in an effort to save and repair their ranges. This booklet was mailed to every rancher and farmer in the Midland area. It already has been an effective stimulus to the range conservation activities of the soil conservation district.

The tone of the booklet is set by the opening paragraphs, which sharply distinguish it from ordinary conservation literature. It reads:

"Once, a long time ago, there was a dispute about the location of the boundary line of West Texas. Somebody in the United States Congress said: 'What difference does it make? Nobody wants any of that country out there anyway.'

"And a long time after that it became land that only the word 'fabulous' will describe. Land that produces oil, cotton, grain sorghums and cattle . . . land that defies wind and drought . . . land that 'comes back' and pledges again its loyalty to mankind.

"And West Texans love that land.

"West Texas land has been good to us . . . and when this drought is broken we will have an opportunity to show our appreciation . . . by nursing it back to its full productive capacity."

The brochure has created a great deal of discussion. It has called attention to the problem. It has presented vital information. And most important, it has been good for the morale, for it has shown that the major business interests of the community are concerned with the rancher's problem and actively support constructive conservation measures.

It is an example of what a real live chamber of commerce can do to promote sound land use and conservation in its trade territory.

—BEN OSBORN, *Midland, Texas*

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